Experiments upon the Resistance to Shock of Beton Floors and Arches in Brick Masonry.

TRANSLATED FOR ENGINEERING NEWS FROM *Central der Bauverwaltung.*

It has been a recognized fact, for some years past, that beton floors are capable of carrying very heavy loads, and they are employed in preference to brick arched work for such purposes. But the great resistance of beton floors has not yet been established in cases where the load is subjected to any vibratory movement. We have yet to be assured that these shocks have no evil effect upon them.

A warehouse has lately been constructed at Leinhaure, near Hannover, in which some of the floors were in beton and others in arches of brickwork. This warehouse, which covers an area of 4,000 sq. metres (43,040 sq. ft.) is used to store, among other merchandise, many pieces of iron, which give rise, during their handling to very considerable shocks.

FIG. 1

A series of experiments were made to test the relative merits of the two floors, and the results of the experience there obtained may be given as follows: The beton floor, shown in Fig. 1, is slightly concave beneath, and is made of five parts of washed gravel, formed of fragments of quartz, ½ in. to 1¼ in. in diameter, to one part of Portland cement, tempered with the smallest quantity of water possible. The beton thus made was spread over the lagging and rammed, a coating of about 1 in. of one cement to one sand being put in over the beton. This mortar penetrated into the interstices of the gravel, forming the arch proper and increased the bond. The floors of brick masonry were built as in Fig. 2.

FIG. 1

The bricks used in these arches rested at each end on I beams, and offered a resistance of 2,800 to 4,200 lbs. per sq. in. A slow-setting mortar was employed, made of 1 part Portland cement to 3 parts of sand. The arch which was 2m. 30 (7.54 ft.) long, was covered over one portion with asphalt, about ¾ in. in thickness; and in another part with a coating of ¾ to 1 in. of cement mortar, one cement to one sand.

Three other arches were constructed like the preceding in dimensions, but built of brick of less resistance, less burned, and made of clay mixed with sand. The mortar used in the construction of these three arches differed; thus the first (Arch II.) was built with a mortar formed of ½ part fat lime to 1 part Portland cement and 4 parts sand; the second (Arch III.) was constructed with a mortar composed of one part lime, one part cement, and five parts of sand; and for the third (Arch IV.) the mortar was composed of one part cement to four parts sand. Above the three arches was a coating of cement, the extrados being previously made wet and the brick roughened to insure a bond between it and the cement. For the Arches I. II. and III. the thickness of this cement mortar was 2 centimetres ($\frac{75}{100}$ in.) for Arch IV., it was 3 centimetres ($1\frac{15}{100}$ in.)

Fifty-four days after the completion of these arches they were loaded with a uniform weight of 160 lbs. per sq. ft. by using iron blooms. This weight caused no deformation. Fifty-six days after completion, the beton arches were tested by letting fall upon them a weight of 55 lbs. from heights of 1.64 ft., 2.46 ft., 3.28 ft., and 4.26 ft. No deterioration of the mass followed these tests. A ball weighing 110 lbs. was then let fall upon the arches from the above heights again without any serious result. The 110 lb. ball was now let fall from a height of 4.26 ft. several times in the same place. At the fourth blow a slight fissures was observed on the lower surface of the cement coating; at the seventh, a morsel of the beton became detached; and at the eighth, a hole was formed, about 4 in. in diameter at the extrados, and 23 in., at the intrados of the arch. (Shown on Fig. 1.)

An examination of the breach proved the perfect homogeneousness of the beton. It was remarked that no other part of the arch had been damaged.

These same tests applied to the brick arches demonstrated the fact that the resistance to shock offered by the asphalt, was very slight. Thus the covering of Arch I, described above, was pulverized by the fall of the 55 and 110 lb. weights. As to the arch itself, it was only after the 15th blow that some morsels of the arch were detached. At the same time the existence of several isolated fissures were noticed in the cement covering. The damage increased from the 30th to the 40th blow; at the 42d blow a crack showed itself in the upper portion, and at the 49th blow the arch was pierced, as shown in Fig. 3. The brick masonry did not separate from the cement arch which covered it.

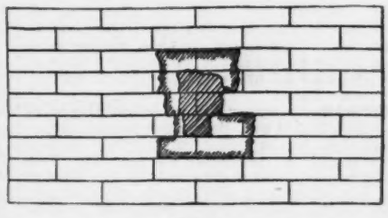

FIG. 3

The Arches II. III. and IV were submitted to similar tests from 67 to 71 days after their completion. Arch II was pierced at the 10th blow; Arch III at the 7th, and Arch IV at the 10th. Figs. 4 and 5 show the form and dimensions of the breach made in the three arches. The diameter of the hole made in the extrados was that of the falling body, but the diameter in the intrados was from 17½ to 23 inches.

FIG. 4, 5

The result of these experiments, show that the arches of beton, and of brick covered with cement, are about equal in their resistance to shocks, supposing that brick used is of excellent quality. The importance of the breach depends upon the velocity and weight of the falling body.

In the above experiments, the arches had a thickness of 9 centimetres (3.54 in.) corresponding to the height of the beams used; but if a floor 22 centimetres (8.65 in.) had been desired, the effect would be to increase the thickness of the beton covering the brick arch; and this beton would rest upon the upper flanges of the I beams.

For the purpose of examining the effect of shock upon an arch of this last description, a test arch was built (Fig. 6.) The bricks used were of medium resistance, and the mortar was composed of lime, cement and sand, in the proportions of two parts lime to three of cement and ten of sand. The covering was formed of equal parts of cement and sand.

The arch was submitted to the same tests as the preceding arches, 47 days after its completion. On dropping the weight over the I beam, the 37th blow reached the metal, the cement covering of 3 centimetres (1.18 in.) being completely pulverized.

The beton over the arch was then tested, where it had a thickness of 5 centimetres (1.96 in.) and at 71st, blow rupture was produced. A weight of 110 lbs. was used, but the

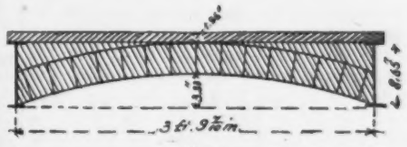

FIG. 6

bottom was a plane surface instead of being spherical, as before.

The conclusions arrived at from these experiments were as follows:—

1st. That all things being otherwise equal, the resistance of arches is the same, whether they are constructed entirely in beton, or in brick masonry with a beton covering.

2nd. That the resistance of the arch of strong, well-burned brick, laid in cement mortar, is more considerable than the arch of beton alone.

3rd. That floors made of iron I beams, with arches of beton, have the advantages over brick arches, of presenting a more perfect bond between the arch and its covering; and as a consequence the filling will the better resist energetic and repeated shocks. This bond can be obtained with bricks with a roughened surface, but is very difficult with Holland brick with smooth sides.

4th. That it is sufficient, for the preservation of the arch proper, to cover it with a bed of cement 2 centimetres (.78 in.) thick (whether the arch is in brick masonry or in beton;) but that the resistance of the arch is much increased by the greater thickness of this covering.

5th. That a thickness of 3.5 centimetres (1.37 in.) of cement above the upper flanges of the I beam is sufficient to guarantee the arch against shocks which would damage these beams.

The Water Supply and Sewerage of Mountain Cities in Mexico.

To the Editor of the *Mexican Financier:*

The immense resources developed in working the mines of the Republic have caused the location of several of the most important cities in the mountains where these mines exist. Among the richest of these may be mentioned Guanajuato with its suburb Marfil, Zacatecas and Pachuca. These are located with all the topographical features favorable to health, but the neglect of sanitary improvements has developed a deplorable death rate in most cases with which the writer is acquainted. The unexcelled climate of the plateau and mountains of Mexico, which may be termed the Italy of America, would make these cities desirable as health resorts for invalids from the North, were it not for this unfortunate state of affairs. Any suggestion offered for the elimination of the elements causing the trouble should be received by the municipal authorities as friendly criticism, and not as captious fault finding, and in this spirit the writer begs the indulgence of the necessary space in your columns to present the salient features covered by the title of this paper. The late article on the "sewerage and drainage of Mexico" will apply with equal force in its general features, to all Mexican cities. The separate system from which all

storm water is rigidly excluded, with a duplicate sewer to relieve districts where the rainfall causes serious trouble, will be found the most economical and the only effective plan to be followed. With the steep grades of the streets in most cities in mountains the lateral sewers need be but 0.15 meter in diameter and should be made of hard burned vitrified clay pipes, with water tight joints to prevent the saturation of the subsoil with the sewage which is a prevalent cause of disease. Any subsoil water which it is required to remove can be gathered in open-jointed tile pipe, of 0.05 meter diameter laid in the same trench with the sewer and entering it at suitable points, in such a manner as to prevent the back flow of sewage into the tile pipe. The size of the main sewer, into which these laterals discharge, is dependent on the population provided for; where a good fall could be obtained, 0.50 meter is enough. These pipes could be made in this country, and the cost of a complete sewerage system should be within the reach of any of the rich cities mentioned. The sewage in some cases could be utilized for irrigating land adjacent to the point of discharge, and with the valuable fertilizing qualities should procure a revenue to the city from the persons benefited.

WATER SUPPLY.

The question of adequate supply of pure water is vital to the interests of all cities. The source of supply must vary according to local circumstances, and may be classed under the following heads:

1st. Water stored in reservoirs during the rainy season.
2d. Never failing streams.
3d. Springs.
4th. Artesian wells.
5th. Ground water.

In Mexico the first method is most objectionable, as the long continued dry season, during which no flow would enter the reservoir, would cause the water to become inferior in quality and the loss by evaporation would also be immense. The evaporation from reservoirs in the New England states is greatest during August, during which month it aggregates four inches in depth. In the absence of data I assume it to be in Mexico, on an average, no less per month, giving four feet in depth to be provided annually for this loss, and these four feet being from the water *surface* would amount to a much greater depth were an equal amount taken from the contracted area at a lower depth. Where circumstances compel storage reservoirs as the source of supply all the water should be filtered before entering the distribution pipes. Filtration through beds composed of broken stone or gravel, about the size of a hen's egg at the bottom, with layers gradually decreasing in size to fine sand at the top, the water being flowed in the sand and gathered into drains at the bottom of the filter bed, will remove matters in suspension in the water. These beds will filter about 90 gallons per day per square foot of area, or, in round numbers, 1,000 gallons per square meter. About one-half inch of the layer must be removed occasionally, as it clogs up with the impurities retained.

The second and third methods for securing a supply may be considered together. The quality of the water would determine the preference, but probably in but few cases will any single stream or spring furnish an adequate supply during the dry season, and the objections against storage of water in the first case would apply, in a modified form, to utilizing water by means of storage, in large quantities, in any event.

ARTESIAN WELLS.

Many persons who have not investigated the conditions necessary to procure water by means of artesian flowing wells assume that it is only a question of the depth the well is driven when an abundant supply will be secured. No idea in connection with water supply is more fallacious. The geological and topographical conditions necessary for success in this case are extremely easily understood, but not generally known by the general public. Suppose a soup plate to be placed in another, and the intervening space filled with water. Then bore a hole through the upper plate and a flow will result until a hydrostatic equilibrium is obtained. This is the whole theory of artesian wells. They can only exist when the water is derived from an elevation above the ground where the well if located, and the water bearing stratum confined between impervious strata, such as clay. In the above case the hydrostatic pressure from the source forces the water to the surface. Any attempt to obtain water for cities in the mountains by means of artesian wells will be a hazardous expenditure of money with no certainty of success. While it is possible water may be obtained by this method it is by no means certain what the *quality* would be in the event of success.

GROUND WATER.

We now have the last method of supply to discuss, viz., ground water, by which is meant water secured by means of large excavations, afterwards covered, in most cases to prevent the deleterious effects of the action caused by exposure to the sun. The most favorable material for the storage of water in the ground is coarse gravel, which contains about 30 per cent. of void spaces, that is, a cubic meter saturated with water will contain about 80 gallons. When a sufficient area of good water-bearing strata can be obtained, and the quality of the water is good, it is the best source from which to obtain a supply in this country for the following reasons:

1st. It is not exposed to the sun, and therefore the evaporation is slight, and no deleterious vegetable or animal growths will be generated.

2d. It is filtered by nature in its passage through the earth.

3d. When situated favorably it is not subject to either vegetable or organic contamination.

Before determining the source of supply careful consideration must be given to all conditions affecting the success of the project. Too hasty a conclusion in this matter may cause a large expenditure of money followed by the ultimate failure of the works to furnish an adequate supply.

The fact of the water being *below* the level of the city should not be considered as objectionable if it be superior to another source where it could be delivered by gravity. The cost of pumping into a reservoir in the United States, including fuel, attendance, repairs and interest on the cost of plant, with coal at $7.00 per ton, and an engine of fair "duty," does not exceed $10.00 per million galls. for each 100 ft. the water is elevated. In Mexico the expense would, of course, be greater, but $20.00 per million galls. for each 100 feet elevated would cover the cost. The reservoir should be of capacity to supply the city for a few days in case of accident to the machinery, and would permit the engine to work, to its full capacity. Direct pumping into the pipes, or the use of a "stand pipe" is extremely expensive, as the engine must be constantly at work; requiring a double set of attendants, supplying water under great fluctuations of demand, and rendering duplicate machinery necessary to provide for accidents. With a good engine, pumping into a reservoir, 1,000 lbs. of coal should pump 1,000,000 galls. 100 ft. high. In the near future, I understand, the Mexican Central Railway will import coal as an important factor of their freight, which will enable manufacturers and others to obtain it at reasonable prices on the lines of the railways of the Republic.

EFFECTS OF SANITARY WORKS ON THE DEATH RATE CAUSED BY ZYMOTIC DISEASES.

The principal diseases, due to the lack of pure water and effective sewerage, are termed zymotic, and include typhoid fever, phthsis, dyptheria, etc. Following the construction of works of water supply and sewerage the total annual death rate in Mexican mountain cities should not exceed, in any case, 20 per one thousand inhabitants, and probably with the exceptionally healthy climate of the plateau and mountains of Mexico would be reduced to fifteen. As an illustration of the reduction of deaths from the principal zymotic diseases where such works have been built, the following statistics are instructive, the places being all English cities or towns

Place.	Reduction in deaths from typhoid fever. per cent.	Reduction in deaths from phythises, per cent.
Banbury	48	41
Cardiff	40	17
Corydon	63	17
Leicester	48	32
Macclesfield	48	31
Merthyr	60	11
Salisbury	75	49
Warwick	52	19

In no cases were the above places in so bad a sanitary condition, previous to the construction of the works, as the Mexican cities under discussion; it is therefore certain that sanitary improvements, in the latter cases, would make a greater saving in the percentage of death rates than in any of the examples given. Capitalists in the United States would be glad to construct water-works in many Mexican cities, as a profitable investment, if the municipal authorities would meet them half way and grant concessions which would protect the capital invested, but the failure of the authorities to appreciate the benefits offered and defer prompt action will turn the attention of investors in other directions.

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Civil and Sanitary Engr.

Flushing Tanks used with Low-grade Sewers in Rome.*

In the new quarter of Rome, near the railway station o Castro Pretorio, the sewers have been constructed with very light grades, and with a section too large for the quantity of water to be disposed of.

Rains being rare, objectionable matter accumulated in these sewers, and during the early part of February, 1883, the nature of the emenations was such that an epidemic was feared, and the inhabitants of the quarter threatened to leave their houses unless the evil was immediately corrected.

The administration called upon M. Vescovali, Chief Engineer of the Water-service of Rome, to do what he could in the matter; and as the quantity of water available was limited, and the grades and form of sewers prevented any modification of them, the system of flushing was decided upon.

M. Vescovali says: "No publication either French or foreign gave me the least practical information. I did meet with small, and incomplete sketches, but they were without dimensions, as is usual in the published works of the English and Americans. I had to make my own experiments, and worked night and day in obtaining the measurements which would enable my apparatus to work with regularity. I believe that it is the duty of engineers to publish at once any results obtained in their studies that are of general interest, so that their confrères in every country may be saved long and costly experiments. Consequently I put at the disposal of *Le Génie Civil* all my notes and plans relating to this work."

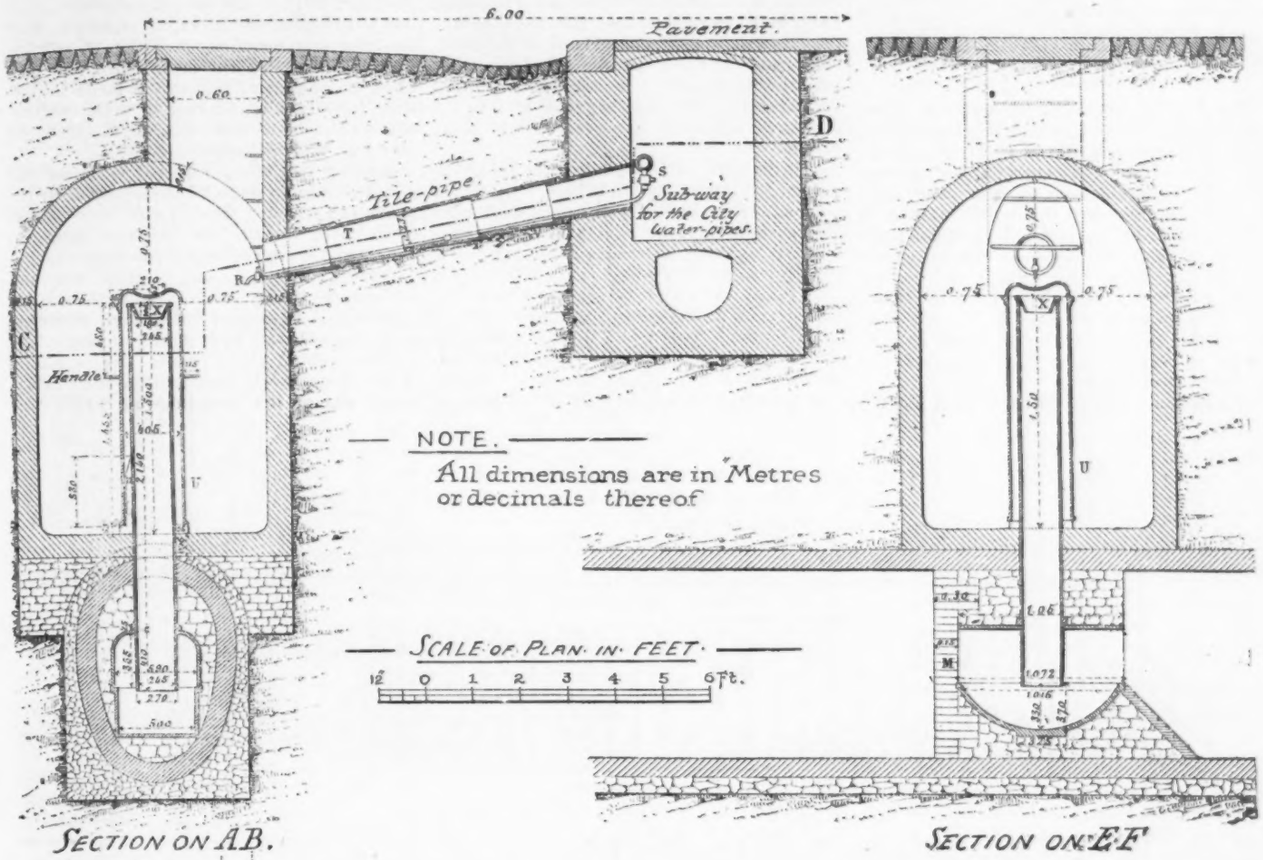
Each reservoir or tank, used at Rome, contained 2,500 litres, (650 gallons), and they were located at the head of each line of sewer and at every change in direction. The healthfulness of the district was completely restored by 32 of these tanks, fed by a conduit which furnished to each tank 5 cu. metres (176½ cu. ft.) of water in 24 hours. Each reservoir is thus filled twice per day, and this flow is sufficient to remove all injurious matter. At first the tanks were filled four times in 24 hours, but experience proved that an economy of 50 per cent. could be indulged in without prejudice to the system.

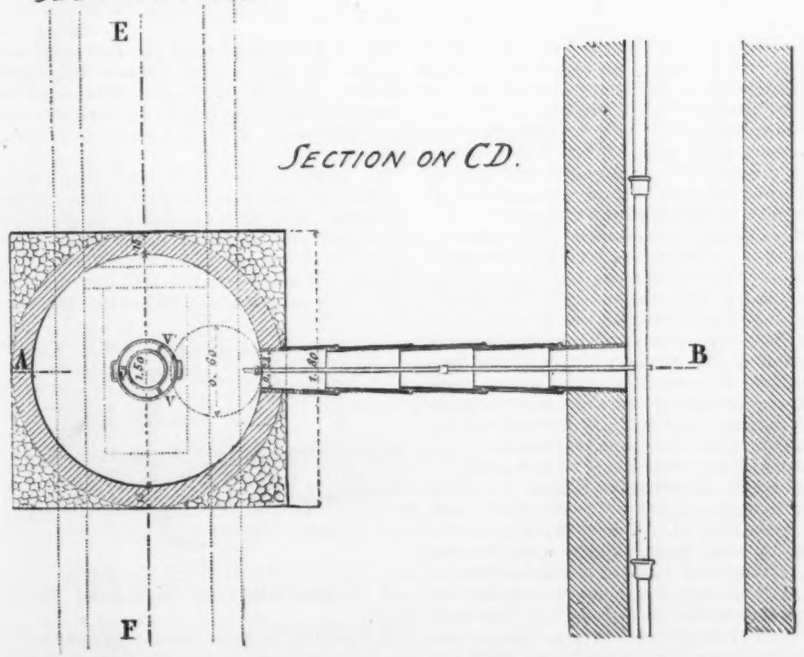
The details of the flushing tank, in which all the dimensions have been determined by experiment are given in the large plate; It will well to add that the following observations are important, for the want of attention to the last detail may bring about failure.

It is indispensable that the first drops of water from the rising column in the annular space around the syphon, should fall into the syphon *without following the sides;* but should form a liquid crown, which in descending from the basin "X" should carry away the air and commence to form the vacuum; very soon a greater volume of water follows, and the tube

* The above description of the use and dimensions of flush-tanks in the City of Rome, is taken from *Le Génie Civil*. While the form is that of the well known Field tank, now introduced into a number of our American cities, the data given will be none the less interesting.—ED. ENG. NEWS.

Flushing Tanks Used with Low-grade Sewers in Rome.





is completely filled, and the syphon is in working order. The 2,500 litres of water rush out in 26 seconds.

The foot of the syphon should not be more than 15 millimetres (.59 in.) below the surface of water in the basin. And to avoid any error of position the pipe is made of cast-iron, and has exactly the dimensions and form indicated upon the plan.

As soon as the reservoir is emptied, it is necessary that air should enter the syphon; to accomplish this, a small pipe or syphon is generally placed in the lower basin, by which the water level there is lowered below the foot of the descending branch of the main syphon, and the air thus admitted.

M. Vescovali, in observing the action of the apparatus, finally decided that with the dimensions given, this small air-pipe was useless. In effect, the relation of dimensions, between the tank and the syphon were such, that the flow was very rapid, and the syphon emptied itself thoroughly and permitted the air to enter by the openings in the envelope which gave access to the water. The emptying of the tank was practically complete.

It was only necessary to give an abundant and constant supply of fresh air, which was accomplished through the earthenware pipe which held the lead-pipe bringing in the supply of water.

The concentricity of the two pipes, forming the syphon, is secured by three small wings cast upon the inner cylinder, which latter also carries three shoulders which support the enveloping cylinder. The three projections of a *centimetre* ($\frac{1}{10}$ in.) each in thickness, form the only obstruction to the entrance of the water into the two pipes.

The entering-basin "X" was at first made of cast-iron, about $\frac{15}{100}$ inches thick; but not being satisfactory, M. Vescovali had these made of yellow copper, cut to a diagram, hammered out, brazed, and well polished. The developed length of the system of sewers where these 32 tanks were placed, is 6,815 metres (22,353 Lin. ft.), or about 220 metres (721.6 ft.) of sewer for each tank. The sewers are egg-shaped and measure 1^{m}-20 (4.93 ft.) in height, and 0^{m}-80 (2.62 ft.) in width. The average grade in the sewers was 0^{m}-0121 per *metre* ($\frac{47}{100}$ in. in 3.28 ft.)

Encouraged by the success of this first venture, accomplished by great effort within the prescribed month of time allowed, the authorities decided to locate a larger reservoir, of about 7,000 litres (1820 gallons) in another part of the city, and use the same syphon simply by increasing the diameter of the tank. But while the tank was emptied, the flow was too slow to permit the re-priming of the syphon; the small air-pipe had to be applied.

The fact has been established that during the warm days of September there was no perceptible odor from these sewers, nor in the streets. This healthy change being accomplished by the use of only (32 × 5) 160 cu. meters (5,648 cu. ft.) of water per 24 hours in these tanks.

The quarter of the city thus improved contains 12,000 inhabitants. The total cost of each flush-tank was 700 francs. ($140.00.)

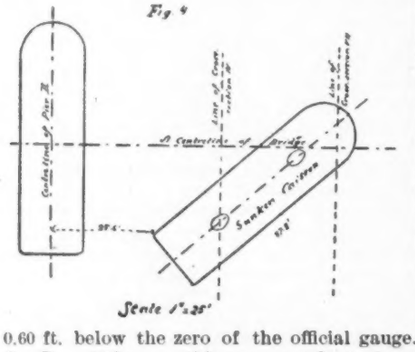
The Removal of an Obstacle to Navigation in the Danube, near Vienna.

TRANSLATED FOR ENGINEERING NEWS, BY GEO. J. SPECHT C. E. FROM THE PAPER BY E. GARDNER, *Transactions of the Austrian Society of Engineers and Architects*, Nov. 6, 1881.

The Austrian Northwestern Railway crosses the Danube, near Vienna, on a bridge 2,370 ft. long (14 spans, each 103⅛ ft. and 4 spans, each 230 ft.) The piers were built on iron-caissons sunk by the pneumatic process. The short time set for finishing the work (summer of 1870 to June 1872), the fact that the piers made angles of about 20° with the direction of the current (the piers were located to conform with the proposed straightening of the river), as well as the great velocity of the current at high-water, ranging from 9.17 ft. to 12.34 ft. per second, combined to make this work one of exceptional difficulty.

The caissons had to be sunk from floating supports, as the enormous winter ice-drifts would have destroyed any stationary works. The foundation of Pier I. was successfully laid before the winter set in. On Nov. 27 the caisson for Pier II. was finished and preparations were made to sink it. To afford an anchorage for the floating stage and to protect it against the ice-flow, an ice-breaker had been built above the site of Pier II. On Nov. 28, 1870, the stage with the caisson was successfully launched and towed into position. On Dec. 9th the lowering of the caisson was commenced, and on Dec. 11th it touched the bottom of the river, the water then standing at

Fig 4



0.60 ft. below the zero of the official gauge. On Dec. 15th everything was ready to commence the excavations, when the Danube, which on the day before stood at 0.80, suddenly began to rise. The excavation was stopped until the caisson could be further weighted with masonry so as to counterbalance the increased height of the water-column. Two days after the water stood at +7.9, and the danger was increased by a strong and steady wind blowing with the stream; in the night, from Dec. 20th to 21st, the thermometer sunk from 38° F. to 14° F.

The caisson was lifted from the river bottom by the rise of the water and remained suspended. By the combination of adverse circumstances above quoted, disaster followed. Early in the morning of Dec. 21st, the chains on the side next the right hand bank of the river, broke, and stage and caisson shifted somewhat out of position; at 7.30 a.m., the chains connecting the caisson with another scow also broke, and stage and caisson moved further down stream.

As there were two wooden bridges below the caisson-site, one a street bridge the other a railroad bridge, and as both would have been most certainly seriously damaged by the caisson striking them, it became necessary to use every precaution to prevent such a catastrophe. At 10.30 a.m. orders were given to cut loose the caisson from the remaining scow and let it go to the bottom. This was a work of exceeding danger and great effort was required to force the bravest of the men to the work. At 2.15 p.m. the right hand stage sunk to the bottom.

The above is the history of this obstacle to navigation; it had to be removed to obtain the regulation depth of 10 ft. in the Danube. The ice-drift was very strong, and by Jan. 18th had demolished the two strongly built ice-breakers, each made of 19 well-connected piles, consequently little work was done at that time. On Jan. 15th an examination was made with the result shown in Fig. 5.

All necessary preparations were made to blow off the wooden frame work of the stages extending above the water, but the river rose again, on Jan. 18th, to +11.5 and the ice demolished this wood-work completely.

As the government insisted upon the speedy removal of the caisson, this was the next problem to be solved. The first attempt was to raise it so that the caisson could be again used, the shaft and air-lock, after several unsuccessful trials were finally recovered, and the attempt was then made to find and raise the 10 chains by which the caisson had originally been suspended. The diver, who was sent upon this duty, found the current too strong, in spite of the extra weights of 50 lbs. each attached to each of his feet. The recovery of the caisson was now abandoned and it was determined to remove it by blasting. The close proximity of buildings and an iron bridge just above Pier II. had to be taken into consideration in the blasting operations. On March 2, 1872, the first trial was made with dynamite, but the great velocity of the current proved a serious obstacle and the explosion of 10 lbs. of dynamite threw up a column of water 16 ft. high, but no material. No concussion was felt by persons standing on the neighboring pier, but the iron-bridge vibrated somewhat and was moved about 8 mm. (⅓ in.) on the pier. Soundings made proved that only 17 cu. ft. of masonry had been displaced, but the sides of the caisson were torn asunder in several places.

The Imperial Department of Railways now prohibited any further use of explosives as dangerous to their bridge, and it was next proposed to sink the caisson below the river bed by dredging the sand from around it. This dredging was commenced on Oct. 16, 1872; on Nov. 17th and 18th the river again rose and filled up the entire excavation made to that time, 3,400 cu. yds. No change in the position of the caisson was observed, and the dredging plan was in turn abandoned.

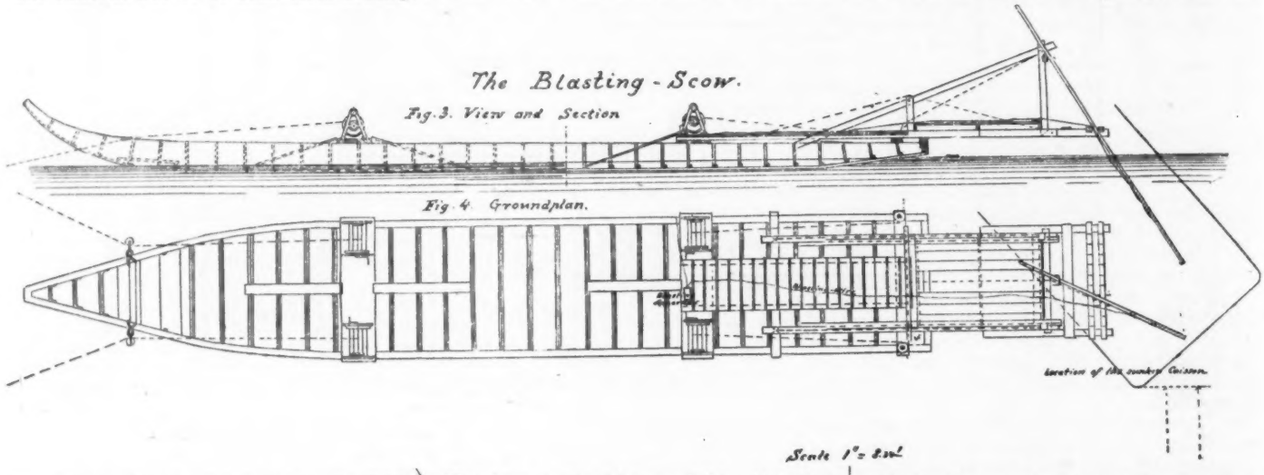
Blasting was again resorted to, after the permission to do so had been finally accorded in the fall of 1873. Capt. Lauer took charge of the work and the blasting-scow, shown in Figs. 3 and 4, was built upon his design.

This scow was 81 ft. long by 12½ ft. wide, and was secured by four anchors above the sunken caisson, a light wooden frame-work extending 16 ft. beyond the bow served to guide the ounding-rod. A chain passed over a pulley in this frame-work, and was fastened to the lower end of the sounding-rod, which was

The Blasting-Scow.

Fig. 3. View and Section

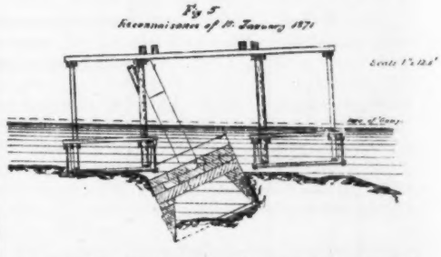
Fig. 4 Groundplan.



made of 2½ in. gas-pipe, at the floor-level the rod was guided by passing between two cross-timbers, through which iron pins could be placed to secure the rod in any desired position; the length of the rod was at first 12.4 ft., later, 15.5 ft.

In fastening the cartridge to the rod, a wooden stick 2 to 3 in. thick and 5 to 6½ ft. long, was driven into the lower end of the pipe; the pipe was split for about 12 in. of its lower length to permit easier driving and the stick secured in place by driving rings over the split pipe. The cartridge was tied to the flattened

Fig 5



end of this stick, with the cap-end turned down.

In blasting, the scow was moved about 20 ft. above the caisson-site, the cartridge attached to the rod and lowered until it touched the side of the caisson, and exploded by electricity; the destroyed stick was replaced and the operation repeated. Weak charges only were used owing to the fears concerning the bridge and buildings. The blasting commenced on Oct. 21, 1873, and the simple charges consisted of only 0.61 lbs. of dynamite; to Nov. 7, 65 of these charges had been exploded and about one third of the area of the caisson had been deepened to the required depth of 10.3 below datum. After this date heavier charges were employed as it had been demonstrated that no damage could follow: from 1.25 to 1.80 lbs o

dynamite were used for each blast, excavating 10 in. in depth. The last of the 223 shots were fired on Nov. 25, when the work was completed.

During the blasting, a shot was fired every 10 minutes, and the following labor was required:—Two men at the windlass to shift the scow; two men to lift and lower the rod; one man to attend to the fastening of the cartridges, and one or two men to fill the cartridges, etc. The battery was worked by the officer in charge. Dynamite No. 1. was used, and as the temperate was low, the thawing out was done in the apparatus shown at Fig. 8.

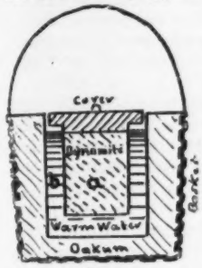


FIG. 8

This is made of an inner iron vessel "a" 6 in. in diameter, into which the cartridges are placed and a cover put on, this vessel is then placed in another "b" holding warm water (maximum temperature 142° F.) and both vessels placed in a basket filled about them with oakum or straw. When the cartridges were thawed out they were taken to a room; where the temperature was kept at 68°, emptied out of their paper shells filled into the tin cartridges used in the blasting. These tin-cartridge cases (Fig. 9.) for the medium charges of 1.23 pounds of dynamite were 3 in. high and 3 in. in diameter, on top was a small cylinder, one half inch high and wide, for the exploder (Fig. 10.) This last was made of two tin cylinders, the upper one fitting exactly into that on the main shell, and filled with a mixture of sulphurate of antimony and chlorate of potash; the lower one was ½ in. high and $\frac{3}{16}$ in. wide and contained 0.3 gramms of fulminate of mercury; this lower double cannister is then wrapped in tin-foil, to avoid explosion by friction, and is inserted in a depression made in the dynamite by a wooden stick. The brassiron ($\frac{1}{2}$ mm thick) is then put in the upper cylinder (Fig. 11.), its two ends are from $\frac{3}{16}$ to $\frac{5}{16}$ mm distant from each other; about two 2 in. above the exploder the brass wire is connected with a copper wire; this as well as the upper part of the exploder are protected by rubber against moisture.

FIG. 9

Fig. 10

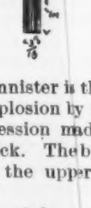


FIG. 11

It sometime happened that the charge froze a second time while being deposited; if the weather was so cold that this was liable to happen, stronger exploders and a more powerful electric machine were used.

Soundings were made before and after each blast with about the following results;—

Using charge of	Vertical depth of excavation
0.62 lbs. dynamite	9 inches
1.24 " "	9½ "
1.86 " "	9½ "

223 shots were fired altogether, as follows:—

91 shots of 0.6 lbs. dynamite		=58.5 lbs.
114 " " 1.2 " "		=141.5 "
18 " " 1.8 " "		=33.5 "
223 shots	total	231.5 lbs

14 actual working days were required.

The area of the sunken caisson was equal to 920 sq. ft., the blasted material amounted to about 53 cu. yds. We would have therefore, per sq. ft. of area of caisson, $\frac{223}{920}$ =0.24 shots with $\frac{231.5}{920}$ =0.5 lbs. of dynamite. The actual cost of the entire work was $1310, or $\frac{1310}{53}$° = $24.71 per cubic yard of material blasted.

The Forth Bridge.

EDINBURGH, JUNE 13.

Favored by an exceptionally mild and open winter, the contractors (Messrs. Tancred, Arrol, and Co.) have been able to make great progress with the work of the Forth Bridge.

I shall first refer to the workshops. They cover a vast area, and consist partly of covered sheds, and partly of a wide open space over which there are laid down lines of rails for carrying the traveling shops in which the steel tubes of the cantilevers are fitted together and built up. It may be noted that these workshops as well as the works on the site of the bridge, are lighted with the electric light, so that the whole of the operations are carried on by night as well as by day, successive relays of workmen being engaged for that purpose. The number of workmen employed on the different parts of the work varies from 900 to 1,200. It may be inferred from the stupendous character of the works and from the number of men employed on it, that the plant required for carrying it on is very extensive. Its cost is estimated, on a rough calculation, at £100,000.

The most cursory survey of the workshops serves to satisfy anyone that this estimate is within the mark so extensive and manifold are the appliances and so ingenious and costly the contrivances employed in the preparatory operations. First we are introduced to a cleverly contrived and quite original machine for testing the strength of the steel plates. Then, on the principle of diamond cutting diamond, there is a circular steel saw which cuts the plates of solid steel as deftly as if they had been made of wood. There are hydraulic rams for bending steel plates into the curvilinear form required for the tubing of the bridge. These plates of solid steel are 151¾ in. in length, 51½ in breadth, and 1¼ in. in thickness. Before being introduced into the hydraulic press, the plates are brought to a red heat in a gas furnace, which imparts to them a temperature of the necessary intensity and also of trustworthy uniformity. Another very ingenious and powerful machine is that which is used in curving angle-irons. There are also powerful machines for planing, dressing, and drilling the steel plates, all of which work with the utmost certainty and regularity.

So large are the steel tubes of which the cantilevers are to be formed that, instead of their constituent parts being taken to a workshop, the workshop has to be taken to them, and has to travel with them in the course of their construction. The horizontal tube which is to form part of the base of the first cantilever is now being put together. This tube is 150 ft. long and 12 ft. in diameter, and in its circumference there are 10 steel plates 1¼ in. thick. The travelling shop engaged in its construction is self-contained. It has its own steam engine and boiler, its own system of drilling and riveting machines, and its own complement of workmen. At one and the same time the engine keeps five drilling machines in motion at different parts of the circumference, and pours jets of water on the drills to counteract the friction. From this operation one gets a better idea of the vastness and the difficulty of the work than from any description of it. If the mere base line of the cantilever is so enormous, what will the completed structure be? I may recall the fact already mentioned in a former letter, that three cantilevers are to be employed in spanning the deep channels on either side of Inchgarvie; one on that island, one on the south side, and one on the north side. Each cantilever will rest on four piers of solid masonry, resting on a bed of concrete; each of them will rise to a height of 350 ft. above the piers, and will stretch out an arm 650 ft. long right and left to the centre.

One of the most difficult operations in the construction of the bridge will be that of building the stone piers, four in number, on which each of the cantilevers will rest. For the foundation of each pier an immense circular caisson of iron will be sunk in the bed of the estuary, and will afterwards be filled with concrete. Each of these caissons resembles a huge gasometer or hollow martello tower, 61½ ft. in diameter, and rising to 20 ft. or 30 ft. above the ground. The lowest part of it is an air-tight chamber, in effect a vast diving-bell, in which after it has been placed *in situ* the excavators will work, comfortably enough it is expected, with constant supplies of compressed air. Very satisfactory progress has been made with the construction of the stone piers which are to carry the horizontal girders between the shore and the cantilevers on each side of the river. On the north side, there are, besides a massive abutment which is completed, four viaduct piers and a large cantilever pier on which the arm of the cantilever will rest. The viaduct piers have been carried up to a height of 30 ft. and the girders which they are to carry are now being put together, and will be placed in position before the piers are proceeded with further. This strikes the lay mind as being one of the most astonishing feats of the undertaking. The girders are to be placed on the piers, which are only 30ft. high, and the masonry of the piers is to be carried up 100 ft. higher, with the girders resting on the top of them. On the north side, one of the round piers which are to form the foundations of the cantilever has been carried up to the level of the under side of the coping. It is filled with blue bricks to a depth of 8 ft., through which rises a system of iron rods and holding-down bolts to carry the plate on which the cantilever will rest.

On the south side there will be an abutment corresponding with that at the north side, and nine viaduct piers, besides the great cantilever pier at the edge of the deep channel. Of the nine viaduct piers six have now been carried up to the level of the cut-water, and are ready to receive the girders which are to be raised for another 100 ft. by building the stone piers under them, in the same way as has already been described with reference to the works on the north side. The foundation of the seventh pier is now being laid by means of a tidal coffer-dam, which is so large that after high water twice-a-day, two hours and twenty minutes are occupied in emptying it. A similar coffer-dam for the eighth pier is now in an advanced state. For the foundation of the southern cantilever pier, a huge permanent coffer-dam is being constructed. It measures 115 ft. by 63 ft. and is in two compartments, one of which was completed in February, and the best proof that can be given of the solid character of the work is that since the water was pumped out two months ago, the pump has not once been brought into play.

Although great progress has now been made with the substructure of the bridge, and although it already makes a good show above water, the work has not yet advanced beyond the preliminary stage. It is difficult to say within what time the bridge will be completed, as very much depends on the kind of weather with which the contractors may be favored. I believe they will consider themselves fortunate if they are able to hand over the completed structure to the company within six years from the present time.—London *Times*.

High Railroads.

The following table gives the elevations above the sea reached by some railroads:

The Andian Railway, Peru	17,642 feet.
Union Pacific Railway	7,386 "
Central Pacific Railway	7,020 "
Vera Cruz to Mexico	6,888 "
North Pacific Railway	5,418 "
Bremen Pass, Rhetian Alps	4,484 "
Bordeaux Madrid Railway	4,428 "
Mont Cenis Tunnel	4,234 "
St. Gotthard Tunnel	3,721 "
Proposed St. Bernard Tunnel	5,917 "

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Direct Pumpage and the Reservoir System Compared.

Our esteemed cotemporary, the *Sanitary Engineer*, editorially objects to a statement made by Mr. Billings, of Taunton, Mass., that the direct pumpage system is sometimes, at least, cheaper than the reservoir plan, and bases its objections upon the following figures:

Taking the eight towns supplied by gravity, of which full statistics are given in the table prepared by Mr. Billings, the thirteen towns supplied by direct pumping, and the fifteen towns supplied by pumping to reservoirs, which have nearly the same aggregate population as the direct-pumping towns, the results are as follows:

	Gravity.	Pump Direct	Pump to Reservoir.
Number of towns compared	8	13	15
Total population	130,813	349,869	350,986
Total cost of water-works	$3,492,217	$6,517,704	$10,448,738
Miles of pipe	238.6	466.9	599.6
Number of service-taps	15,856	26,173	51,325
Annual expenses for interest	$106,763	$377,744	$546,025
Annual operating expenses	51,405	221,849	186,083
Total annual expenses	$218,168	$599,593	$732,108
Average daily supply, gallons	13,030,000	24,000,000	22,000,000
Average daily consumption per tap gallons	822	916	428
Annual cost per tap	$13 76	$22 91	$15 12
Annual cost per mile of pipe	914 37	1,462 62	1,221 00
Annual cost per head of population	1 67	1 71	2 08

From the above the deduction is made that direct pumpage will cost the consumer fifty per cent. more than the reservoir system; and the conclusion is drawn that "when the public owns the works, it will be better to spend a little more money and have a reservoir; but if it is a private enterprise, direct pumpage will be more economical."

Without advocating any special system, for circumstances must practially control the adoption of either, we cannot allow the above deduction and conclusion to pass unchallenged, in the light of the figures used.

It takes time to educate a community up to the full value of a water-supply, and its proper use; and as the direct pumpage system is of very recent origin as compared to the reservoir plan, its use is confined to the comparatively new works. This will explain why we find only half as many service-taps, in the 13 direct pumpage towns, as there are in the 15 reservoir towns.

But the average daily supply by direct pumping exceeds the supply from the reservoir towns; and if we make the comparison by taps, which the *Sanitary Engineer* says is the only rational method of getting at the cost, we find the direct supply giving 917 gallons per tap, and the reservoir supply furnishing only 429 gallons per tap. This being the case it is not surprising that the first system cost $22.91 *per tap* as compared with $15.12 *per tap* for the second. Thus, for the actual present cost of the direct method it would seem to be the more expensive, as stated.

But in the towns cited the aggregate population is the same, and it is only fair to suppose that in time the average demand will be likewise equal. As the taps increase in number the average rate *per tap* will decrease, and when the number of actual consumers per population are equal, we should say from the above table, that the direct system would be much the cheaper. As the case stands the cost per head of population is $1.71 for the direct, and $2.08 for the reservoir system.

The fact that the towns with the least number of taps use the most water, is only a further proof of the newness of the works and the lack of proper waste prevention; the people are yet too prodigal of their freshly acquired privileges. The reservoir towns have nearly 200 miles more of distribution pipe, and we must either conclude that one set of towns wastes its water, or that the other set have an inefficient supply. And if either case is correct no fair comparison can be made between them affecting the merits of the two systems. Under proper management and regulation of pressures, the amount per tap delivered should be practically the same with either system.

We do not see either how the question of ownership effects the choice of systems. The public administration of a water-supply is generally conceded to cost more than the private management of similar works; but this rule applies equally well to all other public works and would be felt whatever system was in use.

River and Harbor Appropriations.

The bill, appropriating $13,909,200 for the river and harbor improvements, has been signed by the President and becomes a law. It is the first one passed within three years, and the amount is thus not as extravagant as it appears.

These annual appropriations have been rapidly increasing in size, from $3,975,900 in 1870 to $18,743,875, asked for, in 1882. The reckless figure last quoted aroused the public indignation and the people condemned this public waste and most evident corruption in such unmistakable terms that a forced halt was called in the distribution of the tempting national surplus. The whole system had become a public scandal, and local schemes having no proper relation to the national commerce were forced upon the appropriation list by a combination of selfish and often corrupt influence, among our law-makers, and public funds were recklessly used to forward private interests.

This evil, having in a measure brought about its own remedy, we can now look over the field and take some account of the mischief done, and plan against a repetition of this shame. During this conflict between the people and their legislative head, many important public works have been suffering, for a lack of funds. The War Department and its efficient corps of engineers have had denied them the appropriations absolutely necessary for carrying on public improvements of vital importance to our commerce, and, as at Flood Rock in our own harbor, money has been wasted in simply preserving works which should long ago have been finished. The people must pay for this and the engineers must unjustly bear their share in the odium brought upon them by this waste of public money.

Secretary Lincoln, when finally called upon for an expression of opinion regarding the bills before the committee of 1882, specified many items in which "the substantial benefits to general commerce were so obscure and apparently insignificant as to vindicate the doubt indicated by the inquiry." But in the face of his objections many of the condemned items were included in the bill as reported; so hard was it to breaking up this system of "log-rolling."

The truth is that beyond the benefit he may personally derive from the favor of his constituents, or the patronage of the lobby, the average congressman has little conception of the actual needs of the case. He is subject to much temptation; holds his office often by feeble tenure, he is ignorant of the great national need, and measures his views by the limiting confines of his own district. In a word he is human, and too often attempts to weigh the public weal on his own little local scales. If he can buy another term of office at the public expense he will do so regardless of all the proprieties.

Under our system of government the remedy for this evil is hard of application; we make our congressmen and they make our laws, and we must either send less selfish material or so amend the system that the law-maker is compelled to give more heed to good counsel.

The government possesses a corps of men specially trained to examine, recommend and superintend the construction of our public improvements; they have no local interests to serve, they are traditionally above reproach, and no scandal has ever sullied their good name. They are certainly better fitted to advise the expenditure of public money, for the purposes named, and to locate the work, than is the average politician, and their advice in the matter should have more weight than it has.

We refer to the Secretary of War and the U. S. Corps of Engineers; and while all proper restrictions should be enforced, we contend that they should be accorded their proper position as an advisory body, and not be made merely the servants or tools of a body of men ignorant often of the first principles involved in the scheme upon which they assume to pass judgment. Were this the policy we would hear less of the widening of ditches and deepening of shallow creeks in the interior of a State, where the only party benefited is the contractor who does the work and the legislator who thus secures a re-election.

Government Use of the Metric System.

In the Congressional Committee on Coinage, Weights and Measures, two or three months ago, Messrs. Everhart of Pennsylvania, Hardy of New York and Chace of Rhode Island, were made a sub-committee on the metric system. Mr. Everhart introduced in the House of Representatives, June 30, 1884, the following bill, which appears to be the outcome of their consideration of the subject:

A BILL TO ESTABLISH THE METRIC SYSTEM OF WEIGHTS AND MEASURES IN THE DEPARTMENTS OF THE GOVERNMENT.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress Assembled, That from and after the fourth day of March, anno Domini eighteen hundred and eighty-nine, the metric system of weights and measures, as recognized and expressed in section thirty-five hundred and seventy of the Revised Statutes shall be exclusively employed by the several Departments and branches of the Federal Government in the affairs of the United States; *Provided*, That in all other transaction than those in

which the United States is a party it shall be lawful to employ the weights and measures now in use.

SEC. 2. That a knowledge of the said metric weights and measures shall be taught in all the schools and colleges now under the control of the Federal Government or hereafter aided by it, or such knowledge shall be required for admission to the said schools and colleges..

SEC. 3. That all laws inconsistent herewith are hereby repealed.

This is on the line of progress pointed out by the Committee of Congress in 1866, when the existing permissive law was passed, and they reported that at an earlier date than could be fixed for its exclusive adoption throughout the community, the metric system might be introduced safely into all public offices and for government service. It is already used in several departments in the Mint, the Marine Hospital service, the U. S. Coast and Geodetic Survey and the survey of the lakes and the Mississippi River, and the foreign business of the Post Office. It would be well for others, as the Public Land department and the Weather Bureau, to adopt it, at the discretion of their officers, without waiting for further legislation. Those which won't adopt it till they are obliged to, would get the benefit of the enactment now proposed. This action was foreshadowed also by the passage in 1877, by the House of Representatives, of a resolution inquiring of the heads of the Executive Departments what objections there were to making the use of the metric system obligatory in all governmental transactions, and how long a preliminary notice should be given before its use could be made obligatory without detriment to the public service, etc.

To this inquiry twenty-four departments and bureau officers made replies, which were referred to the Committee on Coinage, weights and Measures, and printed in Report No. 14. H. of R., 46th Congress, 1st Session.

Engineering Societies *vs*: The U. S. Custom House and Post Office.

We have already had occasion to make a short editorial comment upon the vagaries of the U. S. Custom's laws, as exemplified in the collection of duties upon the Transactions of the Institutions of Civil Engineers, sent to members in this country. The Engineers' Club of Philadelphia has now reported, through its Secretary, upon the relations of that club to the Custom House and Post Office, and the summing up of the conflicting opinions and decisions, received by that organization, reveal either, a remarkable state of official stupidity or a crying need for revision in our custom and postal laws.

The decisions are all "official", derived at different times from different sources. To deal first with the Custom House, the following are among the sage conclusions arrived at by those who interpret the law. Engineering societies are *not* scientific societies; that the liability of a package to duty depends upon its *size*; that the Transactions of the Institution of Civil Engineers of England *are* subject to duty, and the Transactions of the North of England Institute of Mining and Mechanical Engineers *are not*; and finally that Transactions of the Institution of Civil Engineers are worth about *three cents* each.

The Post Office rules, that a society, the object of which is the dissemination of useful knowledge, must pay *eight* cents per pound on its published proceedings, while the general press is charged only *two* cents for the same weight; and that the society is not entitled to "the same low rates extended to the general public."

The above interpretations are as conflicting as they are arbitary, unjust and false. We say false because the law was presumedly made by wise legislators, whose policy it was to foster and encourage the very institutions thus wronged.

If an association of engineers, men who by the nature of their profession are in the very van of material progress, is not a scientific body, what, in the name of Webster, is? This authority defines "science" as "knowledge, penetrating and comprehensive information, skill, expertness and truth ascertained." This definition includes all that goes to make an engineer, and his daily duty is to truthfully interpret and apply the laws of nature. Therefore science, pure or applied, belongs to him, with an unassailable chain of title. Science has many branches, and no one body can claim them all, but it makes little odds whether that science is displayed in bridging space or tunnelling mountains or in finding another asteroid or discovering a new law in physics, it is all akin, and what belongs to one, by right of the title "scientific" belongs with equal justice to the other.

The theory that scientists discover and that the engineer, as a "practical man," simply applies these discoveries is an idea of the past. To-day engineering takes high rank among the learned professions, and makes subservient to its needs chemistry and physics, in all their manifold applications; the engineer now discovers new laws and invents new methods of applying them; he does not blindly follow the teachings of some other mind. All engineers may not be scientists but the profession itself is undoubtedly scientific.

If any distinction can be made between the engineers and other scientific bodies, it is that they, more perhaps than any other class, have in their hands all practical science, that which has for its ultimate end the good, comfort and general progress of mankind.

In relation to the other curious points raised by the government officials, we can only say that their very apparent absurity renders them unworthy of further comment.

The Hudson River.

The mean fall of the Hudson River between Albany and New York, except in seasons of freshets is nearly 3 ft. These freshets occur on an average twice a year and during their continuance the river is swollen to more than ten times its mean volume. It scours the alluvial lands through which it flows, taking up in suspension fine particles of the soil and carrying them almost to New York, so that the cities and towns, drawing their water supply from the river, have to provide filtering apparatus and settling basins to free the water from its visible impurities.

The effect of the ocean tides is felt throughout its entire length. At New York the mean rise and fall is 4 ft. and 4 in. At the city of Hudson, 114 miles from the mouth, it is nearly 4 ft. At Albany, 30 miles further north, it is 2 ft. and 3 in., and at the State dam at Troy, 6 miles from Albany, it is about 1 ft. The crest of the tidal wave averages a velocity of 15 miles an hour between New York and Albany, varying in proportion to the depth of the channel. At West Point it attains a speed of 40 miles an hour. This should not be confounded with the tidal current. The latter averages 3 miles an hour on the flood and 4 miles an hour on the ebb, between the places mentioned.

The tidal current brings more than 1,000,000 cu. ft. of salt water per second into the Hudson River. The mean quantity of fresh water discharged by this stream is about 10,000 cu. ft. per second. In low stages of the river the quantity discharged is less than 5,000 cu. ft. per second, while in floods the quantity discharged sometimes reaches as high as 170,000 cu. ft. per second.

Under ordinary circumstances the superior head of the fresh water forces back the salt water, so that while the water in Tappan Sea is nearly as saline as that of the ocean, the first brackish water to be detected in descending the river is in Newburgh Bay. But when the fluvial waters of the Hudson are at their minimum flow, the river water at, and the for some distance above, Poughkeepsie is perceptibly brackish.

PERSONAL.

GRAHAM SMITH, Civil Engineer, on special service for Messrs. Fowler and Baker, Engineers of the New Forth Bridge, returned from San Francisco on Monday last, and sailed for Liverpool by the *Aurania* on Wednesday. He expects to make the trip from San Francisco to Liverpool in 14 days.

MR. W. B. PARSONS, JR., has been appointed Roadmaster of New York and Greenwood Lake Railway in charge of track, bridges, and buildings. Mr. Parsons has filled positions in several divisions of the Erie Railway, the last being Supervisor of the Rochester Division.

Irrigation in Colorado.

Out in the great West, the land of novelties, a new industry is developing which promises employment for numerous civil engineers. The vast arid plains which comprise such a large part of the territory of that section need only the touch of water to cover them with the most luxuriant vegetation. To accomplish this so desirable result, immense irrigating canals are being built, and upon their construction thousands of men and scores of engineers are employed.

One of the largest and most energetic of the companies making a specialty of this work, is the Colorado Loan and Trust Company of Denver. Since June, 1883, this company has owned controlling interests in the following canals whose combined irrigating capacity is 1,000,000 acres. North Poudre, in Larimer County; Uncompahgre, in Montrose and Delta Counties; Grand River, in Mesa County; Fort Morgan, in Weld County; State Land No. 2 and Citizens, in Rio Grand and Conejos Counties, and the Del Norte and Saguache in the San Luis Valley.

The chief engineer of the company is Mr. Walter C. Graves. To aid him in his labors he has organized the following staff of assistants: Mr. W. A. Balcom, Chief Assistant; Mr. E. H. Kellogg, Special Assistant, in charge of bridges and flumes; Mr. J. C. Ulrich, Assistant, in charge of Uncompahgre canal; Mr. W. A. Waddell, Second Assistant, Uncompahgre canal; Mr. Will Ruby, Assistant, Saguache canal; Mr. W. H. Bain, Second Assistant, Saguache canal; Mr. E. L. Jones, Assistant, Citizens canal; Mr. H. P. Bourn, Assistant, State Land No. 2 canal; Mr. A. J. McCune, Assistant, Grand Junction canal; Mr. H. F. Hartford, Assistant, North Poudre canal. Each assistant is in charge of a corps, the entire force of which numbers sixty men. Each corps has a camp, consisting of two or more tents, a cook, and each is supplied with a team.

To give an idea of the work done on one of these canals, we select the following facts gleaned from an article in the Del Norte *Prospector*, on the Del Norte and Saguache Irrigating canal.

The canal is in all about 50 miles long, and varies in depth from 2 to 6 ft. At the head gate on the Rio Grande river it is 120 ft. wide, and gradually narrows from this point until when emptying into the Saguache it is only 12 ft. wide. A tract of 200,000 acres will be irrigated by this system, and the supply of which coming from the Rio Grande, is practically unlimited.

The first contract let upon the canal was to J. H. Conkling & Co., of Illinois, for the first five miles beyond the first 3,500 ft. at the beginning of the ditch. Conkling & Co., sub-let the last two miles of their contract to Nisbet & Yarmell. The balance of the main ditch, some 23 miles, was let in a body to Baker & Ogilvy, of Greeley, who have three company camps of about 50 teams each, under charge of Geo. Fuller, J. S. Courtney and R. C. Norman, respectively. Baker & Ogilvy sub-let the balance of their work as follows for 21 miles from Del

Norte: Fourth mile, G. W. Winchester; fifth mile, T. W. Johnson; sixth mile, Grant & Johnson; seventh mile, T. E. Lewis; eighth mile, Hines & O'Brien; ninth mile, Jack Wilson & Co.; tenth mile, J. J. Garcia & Co.; eleventh mile, Anderson & Dittner; twelfth, thirteenth and fourteenth mile, W. S. Heckart.

The price paid for sub contract work is nearly or quite uniform along the line, and is as follows: Earth work, 12½ cents per yard; gravel, 20 cents per yard; loose rock, 40 cents per yard. No prices are made on solid rock. the first contractors moving that substance, if any is encountered. These prices seem low, but the soil generally is dry and easily worked. Nine-tenths of all plowing is done with a heavy cast iron plow; a steel plow is used occasionally in extra hard work. The heaviest work upon the line thus far was the first three miles of the ditch, some heavy wash boulders being encountered. The majority of the canal is through a rich soil, with very light gravel.

The working system is as follows: The wages are nearly or quite uniform in each division, man and team receiving $4.50 per day and boarding themselves, or $2 per day and board. Teamsters receive $1.75 per day and board themselves, or $1 per day and board. Many teams are employed by the day, contractors furnishing drivers. These teams are hired at $25 per month. Teams are worked in gangs of from twenty to fifty, teamsters generally loading their own scrapers, and dumping same at the suggestion of a dumping boss. Six and eight mule teams are used on plow-work, and no difficulty is experienced in breaking ground as a general thing. At a rough estimate there are from 400 to 500 men employed upon the line of the canal, and from 300 to 400 teams.

A recent law of Colorado grants to any corporation irrigating the now arid and worthless territory belonging to the State, every alternate section of land so reclaimed.

The Panama Canal.

"OH, YES," Mr. Thomas Vincent Norton said on Chestnut Street the other day, "I am just back from one year of engineering work on the Panama Canal, and I left it because I was afraid to stay there any longer. No I haven't been sick down there, but the way the men are dying frightened me off. I didn't wait to catch the fever and be chucked into a mud grave on the Chagres River, where I was last at work. You would hardly believe me if I gave you a straight narrative of the slaughter. At my station seven men, out of a gang of 119, died on the 10th and 11th of May, and things are quite as bad in other places along the line. The places of the dead are filled, up by new laborers, and the company is paying so well that they are never without all the hands they want. That very payment of good wages is one of the worst things that can happen to the men. They swill—swill is exactly the word—the vile rum that is sold at the boarding-houses, and no man who drinks such liquor can live in that climate. The Americans, Scotch and English who have been there for two years, and are keeping sober and have got acclimated, are doing well, but when you reach the natives or the South American and West Indian Mesquites, who never made $2 a day until they struck the canal work, they are dying off in droves."—*Phila. Press.*

A Parisian correspondent writes: "To say that the canal will be opened in 1888 is a piece of pure imagination, to use the mildest word possible in one's vocabulary. To-day, after three and a half years' work, only one-thirtieth of the work has been done, and that according to their own showing. They claim to have taken out 4,000,000 cubic meters of earth along the axis of the canal, and admit that 130,000,000 must be removed. In the three and a half years they have expended on the canal alone, according to their books here, 58,000,000, soles—say $49,000,000 United States gold. To return to the work completed, about one-twentieth of the dredging has been done, and some of it has been done, two or three times over. Of the earthworks, say one-fortieth has been finished, but of this much will have to be done over, as the rains wash it right back again. Roughly, one-thirtieth has been done, or 4,000,000 cubic meters all told. One of the greatest obstacles to the rapid completion of the canal is the red tape of French officialism. The canal is officered to death, for there are nearly 800 officers of various grades."

CORRESPONDENCE.

Cantilever Bridges.

Special Correspondence Engineering News.

ST. JOSEPH, MO., June 3, 1884.

EDITOR ENGINEERING NEWS:—I have noticed several articles in regard to the time when, and by whom, the

ideas of a cantilever bridge were first suggested. I send you the cover of a circular that has been in my desk for years. The date is 1869. The date is a little blurred in the cover sent you but plain in the inside title page.

The engraving upon the cover shows a bridge being erected by building out a panel at a time from either shore, as was done with the Kentucky River Bridge and at Niagara Falls.

I know nothing of the parties issuing the circular, nor whether they ever constructed a bridge in that manner. The circular itself contains plans for iron bridges, principally of the arched and Warren girder type.

Respectfully yours,

F. FANNING.

Corrosion of Cast-iron Pipes.

Special Correspondence Engineering News.

EDITOR ENGINEERING NEWS:— The Paper referred to by the *American Gas Light Journal*, as quoted in your issue of the 5th inst., was prepared from various notes collated for an expert case.

A prominent lawyer asked me: "Suppose a gas explosion occurs in a house vault, by leakage from a street main, following the service pipe, the main being found broken by settlement near the center, with a thickness of about $\frac{1}{16}$ on one side and $\frac{1}{32}$ on the other, on a line laid more than twenty years, what was the cause?" my answer was: "the ordinary corrosion of a cheap and unprotected pipe, cast in green sand, nearly horizontal, of which the probable life was 16 to 25 years."

The paper was intended to show that the rapidity of corrosion of ordinary gas and water mains, as usually exposed, depends largely on the quality of iron used, and on the method of casting: that pipes of 12 inches diameter and under are specially exposed to this action from these defects, that water-works and gas pipe specifications do not properly provide for better work; and that a loss of 33 per cent., or ⅛ inch, in ordinary ⅜ pipes, by the double process of oxidation and tuberculation, destroys their elastic limit, and this has frequently occurred in less than 18 years.

You ask, "in what foundries the above mode of casting iron pipe prevails?" The answer is, that it has been the usual practice, below 12 inches. If any foundries have, more recently, made small pipe castings vertically, in loom molds, of high grade iron, I am not aware of it. The use of coal tar coating is common now for water mains, and in some cases, for gas mains, and usually retards active corrosion 6 or 8 years; but there is no inducement in the present prices of iron, for foundries to volunteer more expensive manufacture.

Yours Respectfully

SAMUEL MCELROY

NEW YORK, July 8, 1884.

A BRIDGE to cost $500,000, is proposed across the Missouri at Leavenworth, Kansas.

Water Supply to Country Houses and Isolated Public Buildings.*

BY W. E. RICH.

In every age of the world and in every clime the prudent man has pitched his camp and built his house on a site where good water can be obtained. A good foundation is necessary for the stability of the building, but the water supply is equally essential to make it habitable. Of many an ancient dwelling or village even the ruins have perished, but the spring or well, which was the oldest institution in it, remains, and still attests the prudence of the founder. The British or Roman camp, wherever it was situated, could not withstand a siege without a reliable water supply, and it is most interesting to those who study such works to identify the source of water in each case. Frequently there was a well within the circumvallation. In other cases there was a well or spring external to the walls, with a covered way, which is easily identified now, for the protection of those who sallied out to it for water. In others the camp was extended on one side towards the valley specially to include some spring.

I should think it probable that in some of the Roman camps on the elevated chalk downs of southern England, storage reservoirs and gathering grounds, and perhaps even ponds, were sometimes constructed for their water supply. In the mediæval castle the well is still pointed to frequently as an object of note—*e.g.*, the wells at Carisbrook and Warwick. When the beleaguered garrison depended only on the surrounding moat for its supply, we frequently hear that is was decimated by disease, and surrendered in consequence.

The old English monastery was generally placed beside a stream which drove the mill, and was dammed up to form the fish-stews, and there was almost invariably a good well or spring within the enclosure. The homesteads and villages of old England clustered round the springs of water, and the highways passed by them; and the same process of natural selection of sites for habitations still goes on in every new country which is being rescued from the waste.

As a rule the habitation was taken to the water, and the first tendency, no doubt, was to place it beside a running stream and dip out of it; but the stream failed or became foul in summer, and was muddy after rain, and the settler would soon follow it to its source, and prefer the clear spring where it first bursts forth. If that is situated, however, in a position unsuitable for the dwelling, the ingenious man would either convey it by an aqueduct, as was no doubt often done in the luxurious days of ancient Rome, or would make an artificial spring by digging a well on the site of the house.

No doubt there have been blunderers in times gone by who have neglected such principles as I have enumerated above. From my own experience I am tempted to think that the nineteenth century must shine pre-eminent in the instances it affords of houses built without a thought of whence water is to be obtained. No doubt there is a natural tendency at the present day to select more elevated sites than

* Read before the English Architectural Association, March 28th. Reprinted from the *Architect*.

formerly for our dwellings, and this has something to do with the evil. The man escaping from the smoke and close atmosphere of a city, where he gets all the water he wants without even thinking whence it comes, naturally seeks a bracing situation on high ground, perhaps close to the summit of a hill, and too often starts his house before he has given a thought of where the water which will minister so much to the future comfort and health of his household is to come from.

Now it has fallen to my lot to give considerable attention to the subject of water supply to isolated country mansions and public institutions during the last sixteen years, and too frequently, I regret to say, I have only been called upon for advice when the building has been already nearly completed. I venture to think that the hydraulic engineer's opinion might with most advantage be sought at an earlier stage, when the exact site for the house is being selected and the general plans and elevations are under discussion, as it is a great gain to have the house in proximity to a knoll higher than its roof, on which a reservoir of ample dimensions can be constructed; and, in the absence of such natural advantages, a tower, capable of receiving a large elevated tank higher than every part of the roof, should be a notable feature. The provisions of water on the site selected should also be one of the earliest operations, as the cartage of water is often a serious item in a builder's estimates and in some cases would help materially towards paying the cost of the permanent water-works.

A direct gravitation supply from a natural spring or stream higher than the house is in every way the best when it is obtainable, as it is frequently in the hilly districts of the north and west of England, Wales, and Scotland, where the rainfall is large and the rock surfaces are almost impermeable; but in the cretaceous and oolitic districts of the south and east of England elevated streams are rare.

The Earl of Kenmare's house at Killarney is supplied from springs about 1¾ miles distant. They yield about 15,000 gallons per day, and are collected in a covered reservoir holding 30,000 gallons, and situated at an elevation of 110 ft. above the house floor. The water is conveyed thence to the house in a 4-inch cast-iron pipe, which bifurcates into fire-mains and service-pipes for drawing water direct all over the establishment. When water is very scarce on high ground, material dependence has to be placed on the rain-water gathered from the roofs into large storage reservoirs; and it is well known in the west of England that the rainfall on the roof of an ordinary agricultural cottage will suffice for all requirements of its inmates if a moderate capacity of storage reservoir be provided. For large establishments so situated an artificial gathering ground is preferable.

At Sir Greville Smyth's, at Ashton Court, near Bristol, a half-acre plot of sloping ground, near the summit of a hill behind the house, is covered with a floor of impervious concrete, with surface gutters for conveying any water falling on it to a 40,000 gallons covered reservoir below. For every inch of rainfall upon this area about 8,000 to 10,000 gallons of water should be delivered into the reservoir. When gravitation supply is impossible there is no help for it but to have recourse to artificial pumping in some shape or other, and the several ways of pumping must be considered. But it is well to consider the question of pumping with that of the source of supply. A well should be like Cæsar's wife, above suspicion. It should never be in or very near an inhabited house. The further it is off the better. It is better closed in than open.

The number of hand-pumps in the world probably exceed that of any other machine, and most small private establishments in the country depend on such pumps for their water supply, but they are ill-fitted for large houses full of modern sanitary appliances and other apparatus for using and wasting water. A man working a hand-pump for an hour would scarcely do more than 60,000 foot-lbs., of useful work in that time. One gallon of water weighs 10 lbs., so if the water in the well is 100 feet below that in the tank to be supplied, he will only raise 60 gallons in that time. Similarly, if two men work together, they will raise 120 gallons in that time, and if the gross lift be only 50 feet, they will, together, raise 240 gallons, but even that is no more than a leaky water-closet will waste in twenty-hours without being noticed.

The nineteenth century rebels against the employment of thinking beings as mere "drawers of water," and thus it is better to replace manual with horse-power in large establishments. Roughly, a horse would do about ten times as much as a man, or would raise about 600 gallons per hour 100 feet. Working six hours a day a horse would thus raise about 3,600 gallons, but he woul l not be fit for much other work afterwards in the same day. When a horse is employed it is better he should be yoked into an ordinary pole horse-power with a circular path from 20 to 24 feet diameter, and he would work at two and a half miles per hour, and should thus drive three throw pumps. Twenty years ago an American type of horse-power, in which the animal stood on an endless band and pressed it backwards beneath his feet, was much employed, but it was found to be very dangerous, and many excitable horses were killed or ruined in working them. Mules or donkeys are frequently used similarly for pumping, and, considering the sorry fare which contents them, are more economical *pro rata* than horses.

The lecturer then went on to explain in detail the numerous mechanical appliances for pumping purposes—water wheels, windmills, steam and gas engines, etc., and gave a full description of the hydraulic ram and its action. He next went fully into the subjects of reservoirs, water mains, constant service, fire service, etc., hydraulic lifts, filtration of water, etc., and concluded with examples of works carried out on various estates and mansions and public institutions. Allusion was made among these examples to Worcester Cathedral, which Mr. Rich spoke of as an isolated building in the middle of a city. There was an immense amount of wood-work, he said, in the tower, for carrying the bells. This wood-work was very dry, and far above the reach of the fire-engines in the city. To meet the risk of fire, engines had been placed in the crypt to work pumps. A pipe was carried up into the tower, with fire-cocks and hose at every stage, providing a supply of water to any portion of the tower where it might be needed. By means of a rose and spray a thick rain of water could also be showered all over the wood-work in the tower.

An Iron Bridge to be Built.

At an adjourned meeting of the Board of Freeholders, held in the Court House on Wednesday July 2d, it was decided to build an iron bridge across Salem creek in place of the wooden structure, known as the Penn's Neck Draw. Mr. D. W. Bowman, engineer of the Phœnixville Works, was present and exhibited plans by which an iron bridge might be built at a cost not to exceed $17,000. The whole length of the bridge by this plan to be 360 feet, two spans of 117 feet each, the span of the draw 126 feet, and to be all iron, except the plank. Surveyors Morrison and Acton, of this city, were engaged in measuring the bridge on Monday, for the purpose of drawing up specifications, and the Clerk of the Board was ordered to advertise for proposals, to be sent in by the third Wednesday in July, at noon.—*National Standard*, Salem, N. J., July 2nd, 1884.

Strath Taieri Bridge, New Zealand.*

BY ROBERT HAY, ASSOC. M. INST. C. E.

The Land Department of the New Zealand Government, in order to induce purchase and settlement, form and construct roads and bridges previously to Crown lands being opened for sale or lease, with a view a facilitating its occupation by settlers; and it was with this intention that the Survey Department recommended the Government to construct a bridge for traffic over the Taieri River, at the point in question. The suggestion having been adopted, the work was entrusted to to the author, who acts as Engineer to the Taieri County, within the boundaries of which the site was situated.

The only wagon-road by which the land proposed to be opened up could be approached, was that traversing the opposite side of the Taieri River, and crossing by an ordinary ford, which, in time of heavy rains, or when the hot north-westerly winds melted the snow on the higher ranges in the vicinity of the head waters, became dangerous and impassable, and the proposed bridge, by obviating this obstruction, completed an uninterrupted line of road from Dunedin, the chief provincial town.

The design determined upon by the author was a wire-rope suspension-bridge, the site generally favoring the construction of such a structure, as rock was found on both sides of the river, on which the piers secured an unyielding foundation, and the banks of the river were protected from the action of the water currents, which form a constant source of annoyance and damage on the river banks in other parts of the plain, where they are generally composed of gravel and alluvial deposit. The approaches to the proposed site were also easy, leading ridges being accessible on both sides, on which drays and wagons could travel in any direction without further cost being incurred in the formation of roads.

The piers are built of hard blue schistose rock, the masonry being block-in-course, or hammer-dressed, ashlar in 12 in. courses, with 1½ in. of chisel draught cut round each course, and on angles of quoins. The four upper courses consist of single stones of the full dimensions of the course; and the masonry is built in Portland cement mortar, in the proportion of 1 part of cement to 2 parts of clean sand, of which an abundance is obtainable in the river bed. Some difficulty was experienced in getting stones of the specified size free from flaws, as rock of the kind used often only shows faults after having been quarried and partially worked by the masons; therefore, although there was plenty of stone in the immediate vicinity of the works, a considerable waste of material and labor was entailed on the contractor. On the completion of the towers, the bed-plates, rollers, and saddles were placed in position on the tops ready for the cables.

The anchorages, owing to the different material met with at the ends of the bridge, are of dissimilar design. On the western side rock was available, in which narrow cuts were made, with a chamber at the rear end to receive cast-iron anchor plates. These plates weighed 18 cwt. each, and to them were attached the anchor-rods; the whole excavation being filled up with concrete, consisting of 1 part of Portland cement, to 5 parts of clean assorted river gravel, the rods and plates were embedded therein. The site of the eastern anchorage consisted entirely of fine river silt and sand, the rock dipping abruptly back from the piers, and it was necessary therefore to provide an artificial anchorage of masonry, the anchor-plates being securely built therein. The stones were of large size, weighing from 15 cwt. to 1 ton, and were set in Portland cement mortar, having the proportion of 1 part of cement to 3 parts of sand; the whole mass was thoroughly bonded and formed a secure anchorage, opposing a resistance of about 300 tons. The anchor-rods and shackles are of Lowmoor iron, and the connecting-pins of steel. The suspension cables consisted of flat plough-steel woven wire ropes 3 in. by ¼ in. in section, fourteen strands with seven wires each, and one similar interlacing strand. The ropes, eight in number, were specially manufactured in lengths of 285 ft.; each was capable of sustaining a tensile strain of 70 tons, or 560 tons to the eight ropes. The flat section of rope was adopted on account of the facility it affords for the suspension-rod attachments, and the backstay clips; also for the equable strain taken by the ropes in passing round the pins and crossing the saddles, thus having a decided advantage over large round ropes or groups of smaller ones in these

* From other selected papers of the Institution of Civil Engineers.

respects. The cables are connected with the anchor-rods by screw-shackles at each end, and the bridge can be adjusted therewith with ease by the road surfacemen, three of whom can, with the ordinary iron bars used by quarrymen, turn the shackles and raise or lower the platform to the required camber.

The side parapets, consisting of "Howe" trusses, form an effectual and rigid superstructure. The upper and lower chords, braces, and struts are constructed of Kauri timber, obtained from Kaipara in the North Island. The transverse bearers, longitudinal beams, abutment-sills, and butt-blocks, are of ironbark imported from Western Australia.

The sills are securely fixed to the masonry at the one end, and to the rock at the other by lewis bolts run with lead, and the ends of the trusses and longitudinals are bolted down securely to the sills. All scarfs in the main longitudinal timbers are specially cut and secured by plates, bolts, and joggles to ensure the whole superstructure being kept in tension.

The planking consists of two thicknesses of Tasmanian blue-gum, placed diagonally, and each layer well spiked, the whole platform generally contributing to the rigidity of the structure; the cables also have an inward splay to conduce to the same result.

The side-trusses were coated with red hematite paint, manufactured in the Province of Auckland; the remainder of the timberwork had two coats of an equal mixture of coal-tar and Stockholm-tar applied hot, the ironwork receiving one coat of red-lead before fixing, and two coats of black paint afterwards.

The material for the bridge having to be obtained from different parts of Australia, Tasmania, New Zealand, and Great Britain, occasional slight stoppages in the works were unavoidable from the delay in forwarding the various requisites; the roads also were at times almost impassable. The distances to be traversed from the seaport were 28 miles by rail, and 40 miles by a rough road over very hilly ground, and the wagons were able to carry only from 3 to 4 tons each trip, which occupied from four to five days.

The materials used in the works were—

Cement	100 barrels.
Ironbark-timber	11,500 sup. feet.
Kauri "	6,500 "
Bluegum	8,600 "
Ironwork (malleable)	10½ tons.
" (cast)	3½ "
Wire cables	3 "
Masonry in piers and foundations	130 cubic yards.
" east anchorage	280 "
Concrete in west	81 "

The cost of the respective classes of labor employed, was—

Masons	14s. per day of eight hours.
Carpenters	12s. " "
Quarrymen	9s. " "
Laborers	7s. to 8s. " "

There was some difficulty in obtaining the necessary labor, the men having to be brought up from Dunedin, 60 miles distant, and provided with accommodation, as the district afforded nothing of the kind.

The contract schedule rates at which the various items were charged, including workmanship and material, were—

	£.	s.	d.
Ironbark timber, per 100 sup. feet	2	14	8
Bluegum "	2	5	0
Kauri "	2	9	0
Malleable iron, per lb.	0	0	5
Cast " ton	18	0	0
Excavation, per cubic yard	0	2	0
Concrete "	2	0	0
Masonry (block in course) "	3	0	0
" (rubble) "	1	8	0
Steel-wire cables, per ton	85	0	0

Messrs. Sutherland and Millar were the contractors for the structure. The total cost of the work was 2,880*l* sterling, exclusive of the Engineer's commission and the Inspector's salary.

The bridge was completed in seven months. The following are the principal dimensions of the bridge, and the calculated strains of the various parts:—

Span between axis of piers	150 ft.
Clear width between trusses	14 "
Versed sine or deflection of cable	15 "
Ratio of the versed sine of the chord to its arc	1/10
Number of steel-wire cables	8
Size of each cable, 3 ins. by ½ in.	
End area or cross-section of each cable	1½ sq. in.
" " " all cables	12 sq. ins.
Ultimate strength of each cable	70 tons.
" " all cables	560 "
Area of decking	2,100 sq. ft.
Dead weight of bridge carried by wire cables	65 tons.
Live load distributed at 70 lbs to the square foot, about	65 "
Greatest possible load	130 "
Greatest tension on wire-cables at center of bridge	162.5 "
Factor of safety for cables	3.5

ENGINEERING NEWS: Three months for One Dollar.

WATER.

TO WATER-WORKS OFFICIALS.

Croes' Statistical Tables of American Water-Works is the most complete Compendium of Information concerning American Water-works in print. It was published one year ago, and is for the benefit of parties engaged in the Construction, Official Management, or Mechanical Operation of Water-works. If there is any such person, Civil Engineer, Contractor, President, Secretary, Superintendent, or Mechanical Engineer of any Water-works in America, who has use for the book, and who has not got a copy already, we will be pleased to send it to him on receipt of one *five cent postage stamp*, with which to prepay it to his address.

THE water for a natatorium in process of construction at Denver, Col., is to be furnished by an artesian well.

A FINAL test of the Water-works at Belton, Tex., will be made on the 10th of July.

HAMILTON, Ohio, has spent $280,205.82 on its system of Water-works.

THE contract for laying the pipe for the Sayre, Pa., Water-works, has been let to Inman Brothers, 32 Liberty St., New York.

THE water supply of the city of Glasgow, obtained from Loch Katrine, is more nearly pure than that of any other large city in the world.

THE Croton Aqueduct has an average grade of 13⅛ in. per mile. The dam is distant about 40 miles from New York, and has an elevation of 160 ft. above mean tide level.

THE city of Ann Arbor, Mich., is going to invite bids from private parties to put in a system of water-works and supply the city, receiving an agreed sum per annum.

THE Lexington, Mo., Water-works scheme has been sanctioned by a heavy majority of the voters and an extra force of laborers put on. The works will be completed in four months, and will be the only system on the Missouri River supplied with clear water.

A BAD burst occurred in one of the Minneapolis water mains during a recent fire. The force was so great that the new stone block pavement and the earth for a considerable distance around the break was torn up. A small boy, who was wading in the water, fell into the water and sank out of sight immediately.

THE new Hackensack water supply to Hoboken, N. J. has recently developed very objectionable qualities. Chief Engineer Brush charges it to the wash, by the recent rains, of foreign matter into the supply streams. The water is muddy, brackish in taste and has an offensive fishy odor.

THE new artesian well put down by the city of Aberdeen, Dak., is now 920 feet deep and the water at the surface has a pressure of 150 pounds to the square inch. Mains will soon be laid and the water distributed to all parts of the city.

BROOKYLN is increasing its water supply, and will expend $140,000 on new works. A plot of sixteen acres at Valley Stream, Queens County, and another of fifty-two acres at Conselyea's Pond have been bought for the Water Department.

THE City Water-works of Salem, Mass., pumped in May 68,389,100 gallons of water in 282 hours and 50 minutes consuming 63 tons and 670 pounds of coal, raising 482 gallons per pound of coal. The total rainfall was 3.40 inches. The amount pumped last year was 76,126,700 gallons, and the rainfall was 3.84 inches.

CLEBURNE, Tex., July 4.—At a meeting of the council yesterday the arrangement with the water-works constructors, already reported, was confirmed. Fifty-one bonds of $1,000 each, which were issued to the works were then sold to the Cleburne Water and Ice Company, the stock of which is owned partly by the contractors and partly by local capitalists. The city pays $3,500 per annum for forty hydrants, and the company pays the interest on the bonds and creates a sinking fund to cancel the bonds by the time they mature.

SEVERAL typographical errors occurred in Mr. Low's article entitled "Mexican Water-works," and which appeared on page 9 of July 5th. They are as follows: In the first column, 14th line from top, omit "high." In the same column, 11th line from bottom, for "are" read "is." In the second column, 9th line from top, for "streams" read "springs." In the same column, 32nd line from top for "$8.00" read "$8,000," and in the 35th line from the top, in second column, for "applied" read "supplied."

AT a meeting of the Water Committee of Pittsburg Pa., July 3rd, contracts for wedge gates were awarded to the Atlas works for $2,100, to Booth & Flynn for 36-inch water pipes at $1.07 per lineal foot; to P. Moran for 6-inch pipes and 3,685 4-inch pipes on sundry streets at 25 cents per foot for all. The Penn Fuel Company was awarded the contract for furnishing natural gas as fuel at the Bedford works at $7,200 per annum. The coal for these works last year cost $6,452.63, and the wages of firemen were $8,194.63, so about $1,000 is saved.

GREENSBURG, Pa., June 25.—The Water-works Company, whose charter was recently granted, surveyed the ground yesterday for the location of the reservoir. A well will be bored on the western slope of Dry ridge, three and a half miles east of town. From this well and a number of never-failing springs will be furnished an ample supply of water, which will be confined by a retaining dam, from which it will be forced to the reservoir on the ridge by a powerful engine. The reservoir will have an elevation of 200 ft. above the town. A large main will conduct the water into the town. The entire cost of the works will be $100,000.

THE concession for the construction of an aqueduct to convey drinkable water from the mainland to Venice, which was granted on January 25, 1876, to Messrs. Ritterbandt & Dalgairns, representing British capitalists, was subsequently handed over by them to the Compagnie Générale des Eaux, of Paris. The aqueduct which passes under the lagoons, the underground pipes for the distribution of the water, and the two large reservoirs in the town, were completed at the end of last year. The total expenditure incurred by the company amounts to 5,000,000 frs. The municipality is to pay the company, from the first day the water-works are in regular operation, 100,000 frs. a year for the supply of potable water to the 120 public wells in the town, which are to remain open three hours a day. After sixty years the water-works are to become the property of the municipality. Private families will be provided with water at the price of 60 cents. per cubic mètre (1,000 litres), and the company will also make special arrangements for the supply of large quantities of water at lower rates. The minimum quantity of water which the company will furnish is 250 litres a day. The water is to be taken from the canal Dei Moranzani.—*The Architect.*

NEWS OF THE WEEK.

Miscellaneous.

DALLAS, Tex., has a $40,000 paving contract going, and $1,500 in the treasury.

BRIDGEPORT, Connecticut, will have a new $70,000 Catholic church at once.

THE contract for building the new court house at Weatherford, Col., has been awarded to J. H. Williken & Co. for $55,555.55.

THE county commissioners have let out the contract for a bridge across the Bosque River at Clifton, Tex., to cost about $11,000.

A BREAKING valve in a water tank sent an 8 in. stream through the windows of a passing train at Youngstown, Ohio, recently.

THE contracts for the building of the long-talked of East Saginaw, Mich., Opera House have been awarded.

A NEW pavement proposed for trial in Kansas City is Colorado sandstone on a bed of concrete six inches in depth.

THE contract for building the City Hall for Rochester, Minn., was awarded June 30th, to Horace E. Horton of that city, for $10,900.

THERE will be twenty-three piers in the river for the South Pennsylvania bridge at Harrisburg. Those on the Cumberland side will be sixty feet high.

REPRESENTATIVES' of different Indianapolis roads have been experimenting with a patent wrecking frog. An engine was thrown from the track and replaced by the inventor and his machine in six minutes.

THE Committee on Drainage has awarded the contracts for building the sewers in Neptune, South, Elm and Violet streets, Lynn, Mass., to J. L. Whittredge, and that for the sewer in Sea street to J. Heath.

ON June 26th the smoke stack of the Colorado and New England Smelting Company at Pueblo, 145 ft. high and containing 365,000 bricks, fell as the workmen were celebrating it's completion

U. S. ARCHITECT RICHARDSON is now receiving bids for work on the Alleghany Co. Pa., Court House; and will continue to receive bids till August 16th, when contracts will be awarded.

PLANS and specifications for the new Court house at Muncie, Ind., were presented July 1st, by the architect, B. S. Tolan, and the contract will be let in six weeks, unless an injunction is obtained to prevent the erection of the new building.

THE committee appointed to investigate the Vandalia Bridge disaster at Logansport, Ind., testified before the coroner that the timbers were rotton and unsafe, and had been for years. They attribute the cause of the accident to the carelessness of the company and their bridge inspector.

A BILL has been passed by Congress and approved by the President authorizing the authorities of the towns of North Hero and Alburgh, in the county of Grand Isle, Vt., to construct and maintain a highway bridge at some convenient point across that part of the waters of Lake Champlain which divide the aforesaid towns.

A MEETING was held July 1st in Cincinnati, at which nearly one hundred contractors and builders were present. Resolutions were passed protesting against a proposed rule of the Board of Public Works doing away with building permits, and requiring all contractors to deposit $25 to guarantee that they will not obstruct the streets and sidewalks.

LAKE Superior *News:* The plans for the proposed bridge from Rice's Point to Connor's Point, have been sent to Washington for the inspection and approval of the United States engineers. The Northern Pacific Railroad Company have applied to the proper government authorities for a detail from the Engineer Department to superintend the construction of the bridge, and it is evident that work will soon be commenced.

A PARTY of students, headed by Prof. Rees, of Columbia College, have established an observatory on top of the New York tower of the Brooklyn Bridge. The tower is to be used as a Government coast survey station, and the position of the bridge is to be exactly located from the surrounding stations. The work of the present party is to take six weeks.

THE bids for the Waterbury (Conn.) sewers, advertised in ENGINEERING NEWS, to be let on the 2d instant, were as follows: Moses A. Austin, of New Britain, $21,712; G. M. Cushing, of New York, $19,847.20; Perkins & Galvin, Boston, $19,521.30; Gaffney & Brenman, Waterbury, $19,489.30. Matthew Kehoe, New Haven, $19,406.00. Contract awarded to Matthew Kehoe. Work will commence about July 15th.

THERE is being built at the Delamater Iron Works, an iron steamboat designed to run under water. It is 30 feet long, 7½ ft. broad, and 6 ft. deep. Water ballast under control of the crew will enable them to sink or float her, and by the device of two rudders whose planes are at right angles to each other, she can be pointed in any direction. The usual outfit of electric engines, compressed air and diving suits, with which readers of Jules Verne are familiar, is included in the design. In war times she may also be used as a torpedo boat.

RECENT Congressional debates on public buildings have brought out some remarkable statistics. The cost of the sites alone for eight Government buildings, in eight leading cities, aggregated seven millions of dollars. For the site on Chestnut Street, in Philadelphia, the sum of $1,451,201 was paid. Boston nearly matched this, with $1,329,096 for her site, and Chicago was not far behind with $1,259,386. The price per square foot shows even more remarkable figures. St. Louis was satisfied with a site costing $5.98 a foot; Chicago with one of $9.90; Cincinnati, with one of $9.96; but for the Philadelphia site the sum of $17.53 per square foot was paid, and for Boston the top price of $27.96. The 47,722 square feet purchased for the Boston building cost more than the 127,116 taken for the Chicago. Exclusive of the money paid for the sites, eight Government buildings at Boston, New York, Philadelphia, Hartford, St. Louis, Cincinnati and Washington, the latter being the still unfinished State, War and Navy building, have cost over $32,000,000.

MM. IMBERT freres, of St. Chamond, have produced a very original diving-bell. In form, the apparatus resembles a huge bottle. It is 7m. in height, and 3 metres in diameter. Its sides and neck consist of two steel plates, 12 mm. thick, firmly riveted and bolted together. The neck contains a spiral staircase leading to the three chambers below, and is closed on the top by a steel cover through which the tubing of a pump used within for sinking or raising the diving-bell passes to the surface of the water. The upper chamber is furnished with reservoirs for compressed air, telegraphic and telephonic apparatus, electrical piles, etc. Five eye-holes, filled with strong glass, enable the engineers to look about on all sides. The middle chamber is furnished with fourteen eye-holes, with lenses for taking observations, and in the centre is a large lens, eighty centimetres in diameter, to inspect the sea bottom. The lower chamber contains the lighting and ballasting apparatus. The bell may be let down to a depth of 200 metres by filling the ballasting chamber with water, which is pumped out and filled with air when the diver wishes to rise.

FROM the *Arkansas Democrat* of July 3rd, we learn that the draw pier caisson of the Point of Rocks Bridge, has reached the rock and the concrete filling began that night. The contractors, Messrs. Andersen and Barr, are pushing the work with all speed.

AS a result of the conference between the Lancaster, Pa., and Chester county commissioners, on Tuesday last the following intercounty bridges, on the Octorora creek, damaged by the recent storm, will be rebuilt: The wooden bridge at Lee's fording, the iron bridge at Blackburn's fording, the Kirk's fording bridge and the bridge at Pennock's forge. Proposals will be asked for the work in a day or two. In addition to the bridges above named our commissioners will have two bridges to rebuild and seven to repair, all of which were damaged by the late storm.—*New Era*, Lancaster, Pa.

Railroads and Canals.

KANSAS CITY has an elevated cable line in process of construction.

THE Denver and Rio Grande road has been opened to Durango.

A TRACT of 60,000 acres of land will be irrigated by a new canal west of Montrose in the Uncompahgre valley, southwestern Colorado.

THE preliminary survey will soon be made for the Bismarck, Dak., branch of the Rock Island Railroad.

THE Wabash Railroad Company have two immense new fire engines mounted on locomotives.

WORK will be commenced immediately on the Tap railroad from Midlothian, Tex., to the Gulf Colorado and Santa Fé Railroad.

LATER advices show that the laws of the Mexican Government hostile to American railways are of more than a years standing but have never been enforced.

THE portion of the Hudson River Railroad between Peekskill and Fishkill, probably exceeded in cost of construction any other section of road of equal extent in the United States.

WORK has begun on a branch line from Waskomis Station, Tex., to Stonewall on the New Orleans Pacific, a distance of fifteen miles.

THE DesMoines, Osceola and Southern Road will be made a standard gauge and extended to St. Joseph, Mo. Work will be continued both north and south.

Two surveys have been made from Stromsburg the present terminus of the Hamilton and Republican Valley Railroad, to Aurora, in Hamilton County, Nebraska.

THE Pan-handle road is experimenting with whistles on their cabooses, to be operated by compressed air. The compressors will be run by gearing from the wheels of the caboose.

THE Russian standard gauge is 5 feet, and the Portuguese and Spanish 5 feet 6 inches, while the rest of Europe has the standard gauge of 4 feet, 8½ inches.

ONE of the feeders of the Leadville division of the Rio Grande railroad is only seven miles long and yet one terminus is half a mile higher than the other. The maximum grade is 406 feet to the mile; the maximum curve is 25 degrees.

IT is reported on good authority that the Cleveland, Columbus, Cincinnati and Indianapolis has prepared plans for extending its lines to Kansas City beginning at a point on the St. Louis and Terre Haute fifty miles east of St. Louis.

THREE hundred men are at work grading the Augusta, Gibson and Sandersville Railroad. It will be completed by November. The line extends from Augusta, Ga., a distance of eighty-one miles to Sandersville.

THE QueenCity and Spring Bank Railroad of three feet guage and eight miles long, is being built in a southerly direction from Queen City on the line of the Texas and Pacific Railroad.

THE contract for grading the St. Albans and Boone County Railroad will probably be awarded in the near future. This line will extend from Boone Courthouse, W. Va., to Walnut Gap, a distance of thirty-five miles.

ENGINEER RAY and party of the Union Pacific having finished the surveys of the Ketcham extension Oregon Short Line have gone to Canas, Idaho, to make survey from the Utah Northern Division westward to Lost River. The distance is something over 100 miles.

THE grading on the Dakota, Midland is progressing between Ellendale and Campbell.

CARO, Mich., July 8.—Yesterday the directors of the Caro and Wilmot Railroad Company arranged with Engineer C. B, Howard, of Detroit, to survey the proposed road. The entire distance will be about 15 miles.

THE best railroad time in the United States as far as the record goes was eighty-one miles, on the New York Central, in sixty-one minutes. The best English record was thirteen miles in ten minutes. The special train that took to Queen Victoria the decision of this government in the Trent case in 1862, ran 131 miles in 144 minutes

THE James River Valley Railroad has a line of 120 miles under construction. It runs from Jamestown on the Northern Pacific to Aberdeen, Dak. Seventy miles of grading have been completed on the Jamestown end, and some 25 on the other. The management hope to get the road in operation in time to move a part at least of this year's crop.

THE Youngstown and State-Line Railroad, a corporation organized at the instance of the Pennsylvania Company, have surveyed a line commencing at a point on the Ashtabula and Pittsburg Railroad in this city, near the Lake Shore Depot, running north and intersecting the Erie and Pittsburg Railroad at Wheatland. Work will be commenced at once.

THE Cincinnati and Eastern trestle-work across the Scioto River bottoms reached the Scioto Valley Road on Thursday July 3d, and there stopped, because the managers of the latter company raised their track three feet to prevent the Cincinnati Eastern from crossing it. To meet the change a large force of men began elevating the trestle, and again the Scioto Valley people raised the level of their road-bed.

WORK on the extension of the Washington, Ohio and Western railway will soon commence from Round Hill, Va., to Berryville, seventeen miles. A considerable part of this section has been graded already. The tunnel through the Blue ridge will not be built now, but a temporary track will be laid over the mountain, which will be used until the company has a surplus to build the tunnel.

THE 157 miles of Japanese railroads have cost the government an average of $91,428 per mile. The actual cost of 112,000 miles of American railroads built in 1882 was $45,750 per mile. The Japanese average is 100 per cent. in advance of this. In view of the facts that labor is cheaper in Japan than in any other railroad country, that the government pays nothing for the right of way and imports all materials free of duty, it is evident that somebody has been making a good thing out of the job.

NOTED CANALS.—The Imperial canal, of China, is over 1,000 miles long. In the year 1681 was completed the greatest undertaking of the kind on the continent, the canal of Languedoc, or the Canal du Midi, to connect the Atlantic with the Mediterranean; its length is 148 miles, it has more than 100 locks, and about 50 aqueducts; and in its highest part it is no less than 600 ft. above the sea; it is navigable for vessels of upward of 100 tons. The largest ship canal in Europe is the great North Holland Canal, completed in 1825. It is 124 ft. wide at the water surface, 31 ft. wide at the bottom, and has a depth of 20 ft., it extends from Amsterdam to the Helder, 51 miles. The Caledonian canal, in Scotland, has a total length of 60 miles, including three lakes. The Suez canal is 80 miles long, of which 66 miles are actual canal. The Erie canal is 350½ miles long; the Ohio canal, Cleveland to Portsmouth, 332; the Miami and Erie, Cincinnati to Toledo, 291; the Wabash and Erie, Evansville to the Ohio line, 374.

A. K. GIFT, of Middleburgh, and Samuel Lentz one of the directors of the South Pennsylvania and Seaboard Railroad, which is shortly to be built, running through the lower part of Snyder County, are now securing right of way along the line. The road takes a Southern direction from Meiser, going down the valley and coming out at the creek, near Burns' from which point it proceeds along the river to Port Scranton, where it crosses the river. A bridge is to be constructed upon the piers where once stood a bridge belonging to the Reading Company. The line then proceeds through the valley, connecting with a road at Ashland, Pa. This road will also connect with the Western roads, making it one of the most direct lines to the West. It will be fifty miles shorter to New York than any other known route. It is thought that a branch will be built from Burns' to Northumberland, connecting with the Delaware and Lackawanna Railroad.

A ROAD between St. Paul, Minn., and Mona, Iowa is in prospect; also one to be called the Grand Marias and Vermillion, which will extend from Grand Marias to Vermillion Lake, a distance of 100 miles. Port Arthur will be connected with Grand Marias by a branch. Iron mines will furnish the principal source of traffic.

GREENVILLE, Pa., June 30.—Work on the old canal railroad, from this place to Erie, will be commenced to-morrow, so we are informed by the civil engineer of the route. King & Osborne, of New York, who built the Panhandle road, are the contractors, and they are bound to have the railroad finished and rolling stock on inside of six months.

AT a point six miles due west from Denver, and at an altitude of 10,000 ft. above the sea level a tunnel is being driven which will shorten the distance from Denver to Salt Lake City by nearly 300 miles. The drift is 10 ft. high, and 9 ft. wide. 1600 ft. have been traversed from the east end and 1000 from the west, leaving 22,600 ft. yet to be pierced.

THE Chicago and Batavia Railway company filed articles of incorporation in the Secretary of State's Office July 1st. Principal office at Chicago; capital stock $600,000; incorporators C. R. Vandercook, Henry F. Friak, John N. Young and others. The object of the company is to construct and operate a railroad from Chicago to Batavia, Kane County, Ill.

ALBANY, July 2.—Articles of association of the Fulton and Cortlandt Street Ferry Railroad Company were filed here to-day. The capital is $850,000, and the company is to continue for 1,000 years. The road is to be constructed from the Cortlandt Street Ferry to Broadway, to Maiden lane to Burling slip, to South street, to Fulton Ferry, East River, returning through Fulton street to Broadway, to Washington street, to Cortlandt Street Ferry, North River. The entire length is to be about two miles.

THE work of track laying has been commenced on the extension of the Wisconsin, Minnesota and Pacific Railroad from Morton west through Minnesota and Dakota to Watertown, and it will be pushed rapidly to completion. As soon as convenient after the connection is made at Watertown a line will be built from Waterville to Gaylord, unitiing by a direct line the Cannon Valley division with the Pacific division, making a nearly straight line from Red Wing on the Mississippi to Watertown in Dakota.

IT is expected that work will soon be commenced on the Cincinnati, Wheeling and New York Railroad. Officers of the construction company have been in New York consulting with certain parties on the subject, and if all goes well the road will be completed, they say before the 1st of December. There are 30.7 miles to be built, and Messrs. Loomis, Wilson and Miller, railroad contractors say they could build that length of road through such territory as C. W. and N. Y. Road is run within 120 days.

THE Minneapolis, Minnehaha, and Fort Snelling Railroad Company filed articles of incorporation in the office of the Secretary of State recently. It will commence active operations July 8th, and extends its term of existence to 200 years. Its capital stock and also limit of liability is $500,000, which is to be paid in installments not to exceed 50 per cent. of the par value of each share as called by the Board of Directors. The object is to construct a railroad, line of telegraph and telephone, to Fort Snelling from Minneapolis by way of Minnehaha; and the office of the corporation will be in Minneapolis. The incorporators are William McCrory, President; (Roeliff Brinkeroff, Vice-president, not included as incorporator); T. J. Janney, Secretary; S. E. Neiler, Treasurer; Judson N. Cross and Frank H. Carleton.

THE section of the Duluth and Iron Range Railroad from Two Harbors, Minn., northward to Tower, the terminus on Vermillion Lake is now approaching completion. The whole distance from Two Harbors to Tower is 68 miles, and on this track has been laid for 40 miles and the grading completed on 20 miles more. All the rails for the road are on the ground, and it is expected that it will be completed by the beginning of August. As soon as the track is laid shipments of iron ore will be begun from the mines of the Minnesota Iron Co. at Tower, as that company has had a force engaged on its mines for some time past. The company has 11 locomotives and 350 ore cars ready for use. The work on this section has been pushed in order to enable shipments to be made by lake this season. As soon as it is completed work will be begun on the 27 miles from Two Harbors to Duluth.—*Free Press.*

AN electric headlight has been placed on engine No. 54 of the New York, Pennsylvania, and Ohio Railroad. It weighs 400 pounds and lights up the track for the distance of a mile.

DURING the last year 187 miles of railroad were built in Indiana as follows: Terre Haute and Logansport, (Vandalia extension) 43 miles; Indianapolis and Evansville, 50 miles; Chicago and Great Southern Block Coal road, 54 miles, and Indiana, Illinois and Iowa, 40 miles.

IT is the intention of the management of the Northern Pacific Railroad to complete the extension of the Cascade Division at once. Fifty miles are already built, and the contract for building 50 miles more will soon be awarded; this will make up more than half the entire distance. The rest would be pushed as rapidly as possible. The tunnel on the summit of the mountain will be 22 miles in length, and several months will be required to complete it. When the Northern Pacific is thus finished to Puget Sound, and connection with the steamship lines to Japan is completed, another of the world's highways will be thus formed. The distance from Puget Sound to Japan is several hundred miles less than from San Francisco.

ARTICLES of associations were filed recently at the State House, of the Minnesota, St. Croix and Wisconsin Railroad Company, being a consolidation of the St. Croix and Chippewa Falls Railway Company, organized under the laws of Winsconsin, and of the St. Paul and St. Croix Railway Company, organized under the laws of Minnesota. The capital stock is $1,080,000. J. L. Colby is President and Howard Morris Secretary. This new company represents the Wisconsin Central extension from Chippewa Falls to St. Paul, a distance of 104 miles. Work upon the new line is being pushed rapidly, and it is the expectation of the company to have connection between Chippewa Falls and St. Paul by January 1st. Forty miles of grading has been completed at the Chippewa Falls end, and several days ago the work of laying rails was commenced. About one mile of rail will be laid per day. Grading is progressing rapidly all along the line, and the roadbed is ready for the rail most of the distance.

IN the construction of the New York, West Shore and Buffalo Railroad a peculiar strata was found north of Catskill. There nature held all the material in equilibrium. First was found eight feet of white clay, and below that fifteen feet of blue clay. Between the two was a very thin sand strata. This forms the subterranean drainage for a large section where springs, rills and rivulets are unknown. By the weight of the road-bed the material was slipped away. The secret was found to lie in the fact that underlying the whole country was a much less solid material almost as light as marl. The effect of an embankment on a hillside was that the material would disappear in the ground. Piles fifty-five feet long, driven when the road was building, now have their bases 105 feet below the surface. Another effect of the filling at places was to compress the sand strata, thus shutting off the underground drainage, resulting in lifting vertically the surface of the ground. By this irresistible process at one point, the country around—30,000 cubic yards of it—was raised vertically fifteen feet. Between Saugerties and Kingston, where the road runs along the sides of hills, the ground has an erratic way of moving off down into the valley at unexpected times, gently carrying the road-bed with it. Then, along the Hudson are struck rock points, with eddies on either side, where the rock has been deeply worn away. Below the mud a rock slope is struck, which varies one to one, two to one and three to one. The wet mud lubricates this rock slope, frictional resistance is destroyed, and the rock placed for foundations quietly slides away out to the middle of the river. Here was a problem for the engineers, solved by their West-Shore brethren successfully however. Along the Erie Canal some wide cuts were made and immense retaining walls built. The cut through "Lovers's Leap," at Little Falls cost the company $75,000—*New York Times.*

THE Harper and Western Railroad was chartered July 2d. It is intended to build and operate a standard gauge railroad from Harper, in Harper County, Kan. to a point near Dodge City, in Ford County, running through the counties of Harper, Kingman, Barber, Pratt, Comanche, Edwards and Ford; also a branch from a point on the main line twelve or fifteen miles west of Harper, southwesterly to a point in Barber County on the boundary line between Kansas and the Indian Territory, thence westerly through the counties of Barber, Comanche, Ford, Seward, Finney and Hamilton in the State of Kansas, or through such of those counties as may be found to be upon the most practicable route from the starting point in Barber County to the west line of the State of Kansas. The estimated length of said road and branch is about 400 miles. The amount of capital stock is $8,000,000 divided into shares of $100 each. The business is to be transacted at Topeka and such cities and towns along the line of said road as may be deemed advisable. The directors for the first year are W. B. Strong, Boston; A. E. Tonsolin, Boston; A. A. Robinson, E. Wilder, J. F. Goddard, James Hagerman and George B. Harris of Topeka, Kan. The following persons signed as incorporators: George B. Harris, J. T. Barnes, James Hagerman, George W. McCoury and H. C. Clements.

THE MEXICAN CENTRAL.—For more than ten years the project of building two railroads had been discussed in Mexico; one extending from the City of Mexico to Paso del Norte, the other from some point on that line to the Pacific coast. The charter of the old Central Railroad, which had been granted nearly ten years ago, December 5, 1874, was on February 21, 1880, transferred by President Diaz to Robert R. Symon and associates, they having a few weeks previously filed articles of incorporation under the general railroad laws of Massachusetts. The work of construction was begun in June of the same year, 1880, after the Mexican Congress had not only issued subsidies of $15,000 per mile, but also passed a bill permitting the road to import all materials for construction duty free, exempted them from taxation for fifty years, and given the right of erecting and operating for ninety-nine years a telegraph line. The Mexican Central has now in operation nearly 1400 miles of road, the work of four years; when completed the entire system will have a mileage of 2700 miles.

The line from El Paso to the City of Mexico for the first 700 miles traverses a smooth plain, then after 150 miles of mountainous country enters a cultivated valley 200 miles in length, thickly settled and blooming like a garden; another 130 miles, winding around hills, through fertile valleys and picturesque lanscapes, brings the traveler into the capital of the republic, 7400 ft. above the sea. No specially difficult engineering feats are presented the entire length of the line, though some trouble was encountered in the valley of Mexico, a broad, flat plain intersected with numerous irrigating ditches and canals.

N. Y. L. E. & W. R. R.—TO SECTION FOREMEN AND TRACKMEN, ROCHESTER DIVISION.—In doing Work on your Sections you will be governed by the following instructions:

1. **Ties, Lining.** Ties to be placed squarely across track, and their ends to be carefully lined with respect to East rail.

2. **Spacing.** Ties to be evenly spaced; if full size, put 16 to a 30 foot rail, and 17 if small. On those sections which have standard rail and angle plates, joint ties must be spaced so that the joint falls half way between them. The angle plates must be spiked in the notches.

3. **Spiking.** All ties to be full spiked. The two inside spikes to be set on the North side of tie, and the two outside ones on the South side, to prevent tie slewing.

4. **Peeling.** All ties must be peeled before being put in track.

5. **Elevation.** To obtain proper elevation for curves, stretch a string 55 ft. long between two points on running side of rail. Measure the distance between the middle point of string and rail. This distance is the proper elevation to give. The elevation to be full at point of curve and to be run off on straight line at the rate of 1 in. in 50 ft.

6. **Level Board.** The elevation to be tested with level board and level, at least every 30 ft. On straight lines, except where approaching curves, the rails must be on same level. Therefore, it is absolutely necessary to use level board on straight lines as well as curves. *Track must not be put up without its use.*

7. **Track on Bridges.** Particular attention should be paid to track on bridges. Be especially careful on the approaches to carry out the grade of the bridge and the elevation, if on a curve, so that trains shall pass on and off without any jar.

8. **Ditches.** All track to be carefully ditched. Ditches to be sloped away from the ends of the ties, and at time of water to be kept cleared of obstructions.

9. **Fence Posts.** All fence posts to be peeled before being used; to be set in ground at least 3 ft. and to be sawed off square with top board when put in.

10. **Crossings.** Planks for farm crossings to be 8 ft. long; for unimportant highways, 12 ft. long; and for important highways 16 ft.; to be set in the square pattern with cross piece at ends and centers filled with ballast.

11. **Frog Distance.** The correct distance from point of 1 in 8 frog to head block is 53 ft. Whenever it is necessary to retie a switch lead, the frog must be moved back or head block forward, so that distance between them is 53 ft. Then put in the standard set of switch ties.

12. **Old Material.** Pains must be taken to keep the track in a neat and tidy condition. Old material to be picked up and taken to tool house, and there sorted into proper piles. Extra rails to be placed on skids by side of track. Old ties to be neatly piled up on same day they are taken from the track. They must then be removed from right of way or burned within one week.

13. **Time.** Take sufficient time to finish every job in a work-man-like manner.

Foremen will be held accountable for the carrying out of the above.

W. B. PARSONS, Jr.
Supervisor, R. D.